WORM CONTROL IN VICTORIA
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Introduction

- There are 22 million sheep in Victoria, of which 75% are Merinos.
- In 1999-2000, Victorian sheep farms produced 155,000 t of wool worth $409m (18% of the value of wool produced in Australia), and 190,000 t of sheep meat (128,000 t of lamb and 62,000 t of mutton) worth $362m (34.5% of the value of Australia’s sheep meat).
- Animal health and management issues are a significant ‘production risk’ for Victorian sheep flocks, especially in the higher rainfall areas on and south of the Great Dividing Range, or areas in northern Victoria with more than 480 mm annual rainfall. Of these, internal parasites (worms and liver fluke) are the most important problems, followed by footrot, flies and lice.
- The worm life cycle, and hence worm control programs, are driven by the interaction of seasonal conditions and time of lambing. Most of Victoria is a high (> 520 mm) or moderate (420-520 mm) winter rainfall area, except for East Gippsland where the rainfall is more uniformly distributed between winter and summer. Spring lambing matches the available feed to the demands of the flock, and is also better for worm control. Autumn and winter lambing flocks generally have more problems with worm control, particularly in the higher rainfall areas.
- On a typical Victorian sheep farm with 2,000 sheep, treatment costs and lost production from worms can be from $5,000 to $10,000 each year.
- Scouring and deaths are the obvious signs of poor worm control, but significantly reduced production occurs in association with a moderate worm infections - a 20% reduction in growth rates and 30% less wool growth in young sheep, and a 10% reduction in wool growth in adult sheep.
- Dags in adult sheep in winter and spring are also related to worms. Affected sheep have low worm egg counts, but an allergic (‘hypersensitivity’) type reaction occurs in their gut following the ingestion of infective worm larvae (link to article on dags).
- Worms also have considerable indirect costs. For example, producers’ decisions about stocking rate, flock structure and grazing management in the high rainfall areas are also influenced by their attitudes to and experiences with worm control.
- Integrated strategies have been developed to effectively control worms in Victorian sheep flocks. These are based on detailed research conducted over the past 40 years, and summarised as ‘Wormplan’.
- Wormplan is based upon a ‘2-summer treatment’ strategy. This can be modified to a 1-summer treatment regime in drier northern areas, or for wethers on farms with good worm control in the south. This strategy relies on killing most worms inside the sheep at the same time the environment (dryness and sunlight) is killing a large proportion of the free-living stages (eggs and larvae) on the pasture.
- Testing for drench resistance, monitoring worm egg counts (‘Wormtests’) and grazing susceptible sheep (weaners) on ‘low risk’ pastures are the other important components of the Wormplan Program.
Wormplan provides farmers with an overall plan of attack for worm control in Victorian flocks, but must be tailored and adapted to each farm. This requires a good knowledge of the worm life-cycle in a local area, combined with active monitoring of worm egg counts in selected groups of sheep at key times to see how the seasonal conditions are influencing worm numbers (see below).

The interaction of the worm life-cycle with the seasonal conditions is not static. Because of the variation from year to year, it’s important to keep monitoring and fine tuning worm control on a farm.

The Major Worm Species

The worms found in sheep in Victoria include roundworms (nematodes), flukes (trematodes) and tapeworms (cestodes). Roundworms and fluke have the most impact on production. Tapeworms look spectacular, but are relatively harmless - many experiments have failed show any detrimental effect of sheep tapeworms on the growth of lambs.

Roundworms

- The most important roundworms of sheep in Victoria are the ‘Small Brown Stomach Worm’ (*Ostertagia* spp), ‘Black Scour Worm’ (*Trichostrongylus* spp) and ‘Thin Necked Intestinal Worm’ (*Nematodirus* spp) (see Table 1).

Table 1: Common roundworms of sheep in Victoria

<table>
<thead>
<tr>
<th>Organ</th>
<th>Common name</th>
<th>Scientific name</th>
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<tbody>
<tr>
<td>Abomasum (4th stomach)</td>
<td>Barber’s pole worm</td>
<td><em>Haemonchus contortus</em></td>
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<tr>
<td></td>
<td>Small brown stomach worm*</td>
<td><em>Ostertagia circumcincta</em></td>
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<tr>
<td></td>
<td>Stomach hair worm</td>
<td><em>Trichostrongylus axei</em></td>
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<tr>
<td>Small Intestine</td>
<td>Black scour worm*</td>
<td><em>Trichostrongylus colubriformis</em></td>
</tr>
<tr>
<td></td>
<td>Thin-necked intestinal Worm*</td>
<td><em>Nematodirus abnormalis</em></td>
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<tr>
<td></td>
<td>Intestinal threadworm</td>
<td><em>Strongyloides papillosus</em></td>
</tr>
<tr>
<td>Large Intestine</td>
<td>Large bowel worm</td>
<td><em>Oesophagostomum venulosum</em></td>
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<td></td>
<td>Whipworm</td>
<td><em>Trichuris spp</em></td>
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<td></td>
<td>Large mouth bowel worm</td>
<td><em>Chabertia ovina</em></td>
</tr>
<tr>
<td>Lung</td>
<td>Large Lungworm</td>
<td><em>Dictyocaulus filaria</em></td>
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<tr>
<td></td>
<td>Small Lungworm</td>
<td><em>Muelleria capillaris</em></td>
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* The most important worms in Victoria.

- These worms reduce the intake of food and damage the lining of the gut surface (‘mucosa’). Blood protein and salts then leak into the gut and food is poorly absorbed. The larval stages of these worms develop on pastures after the autumn break, and so worm infections in Victoria are mainly a feature of autumn, winter and early spring (for life-cycle see Figures 1 & 2).
Figure 1: The roundworm life cycle

The Small Brown Stomach Worm (Ostertagia) has a typical direct life-cycle:

1) Adult *Ostertagia* live in the abomasum (4th stomach). In a susceptible host, each female can produce 300-600 eggs per day. The eggs are passed onto the pasture with the faeces (dung).

2) On the pasture the eggs require:
   a) **Warmth**: 15-25°C is ideal for *Ostertagia*, but other species (Barbers’ Pole) prefer up to 35°C. Development can occur outside this range, but is much slower or with many deaths.
   b) **Moisture**: the relative humidity must remain close to 100% within the faecal pellets for eggs to hatch and larvae to develop.
   c) **Oxygen**: this is no problem if faeces are pelleted, but can be lacking in the centre of wet faecal pats.

3) Given suitable conditions, the eggs hatch, usually within 24 hours.

4) The hatched first-stage larvae (L₁) feed on bacteria in the sheep dung, grow and moult to second-stage larvae (L₂). This process is then repeated, but the third-stage larvae (L₃) retain the second-stage "skin" as a sheath. The sheathed L₃ are resistant to drying, but cannot feed. Their survival depends on the rate they use their energy reserves accumulated during the L₂ stage.

5) In ideal conditions, the L₃ stage can be reached in less than a week. However, the L₁ and L₂ stages are very susceptible to unfavourable conditions, especially drying.

6) The infective L₃ move away from the faeces in films of water after dew or rain. They try and migrate up the pasture, but most remain in the soil or top 2 cm of pasture. There is conflicting evidence about the relative larval numbers on clovers and grasses. Some studies have shown greater numbers on clover than grass, and others the reverse.

7) Survival of the L₃ depends mainly on their activity. In summer, when larvae are very active, their energy reserves are rapidly depleted and most die within 2-3 months. However activity is much less during the colder times of the year, and larvae are quite capable of surviving from early autumn to late spring.

8) Sheep preferentially graze close to the ground, and often select young shoots of grass and clovers where numbers of L₃ are high. They gain some protection by avoiding rank feed around sheep camps, or soiled feed, but if pastures are "wormy", larvae will be picked up every time it becomes damp.

9) Once larvae are picked up, their fate depends on the immunity of the grazing animal. Adult dry sheep usually have reasonable immunity and most larvae are rejected or have their development delayed. If the larvae do reach maturity, the adult worms may be expelled early, or have their egg production restricted. However, in susceptible sheep, such as lambs or weaners, larvae develop to adults and the adult female worms can start laying eggs about 17 days after a sheep eats infective larvae.
All the main sheep roundworms have this basic life cycle. However, the first and second stage larvae of Barber's Pole Worm (*Haemonchus*) can only survive in warm, completely moist conditions, and survival of the L₂ is not as good. Adult *Haemonchus* females also lay far more eggs (5,000 - 10,000 per female per day) than *Ostertagia*.

Unlike the other sheep roundworms, the Stomach Hair Worm (*Trichostrongylus axei*) will develop quite happily in cattle and even horses. *T. colubriformis* prefers warmer conditions than *T. vitrinus* and *Ostertagia*, but otherwise the life cycles of these species are very similar.

*Nematodirus* lays fewer large, distinctive eggs. The entire larval development to L₃ occurs within the egg, thus preventing much of the heavy loss of L₁ and L₂ which occurs with other species. The survival of *Nematodirus* L₃ on pasture is also very good.

Barber’s Pole Worm (*Haemonchus contortus*) can cause serious disease (deaths and severe production losses, especially in younger sheep) because it sucks blood. Its’ larval stages develop best in warmer conditions, and so it is a major problem in summer rainfall or irrigation areas. However, Barber’s Pole is a consistent problem in only a few restricted areas of Victoria - the northern Victorian irrigation districts, during wet summers in East Gippsland and in a few parts of Western Victoria. Thus, Barber’s Pole doesn’t have the enormous impact it has in other States, such as the New England district of NSW.

Most other roundworms are only of minor importance and controlled adequately by the programs aimed at the major worms. Coughing in sheep is often attributed to lungworm, but is more commonly caused by mechanical irritation such as from dust, or occasionally viral and bacterial infections.

**Liver fluke**

Liver fluke are found throughout Victoria, but are especially a problem in the warmer areas north of the Great Dividing Range and irrigation districts. On affected properties production losses from liver fluke are similar to those caused by roundworms.

Fluke have a different biology and life cycle from the roundworms. Rather than having separate sexes, all adult flukes lay eggs. The life cycle involves an intermediate stage in a freshwater snail, *Lymnaea tomentosa*, in which further multiplication occurs see Figure 3. Often only a part of a property will be affected with fluke – eg. consistently wet areas that are a suitable habitat for the host snail.
Figure 3: The liver fluke life cycle

- Adult flukes live in the bile duct of the liver and lay eggs that are passed in the dung. Each egg hatches to form a miracidium. These swim actively, but live only for a short time and so must quickly find a host snail. Once in the snail, enormous multiplication of a single miracidium occurs - up to 1,000 young fluke can emerge, often killing the snail. The young fluke (cercaria) can swim, and eventually lodge on grass stems until eaten by a sheep. In the sheep they penetrate the intestinal wall and reach the liver, where they wander around, eventually entering the bile ducts to become mature fluke about 12 weeks after first entering the sheep.

- The minimum time for the complete fluke life cycle is four months. Control measures centre around treating all animals grazing fluke infested pastures before the host snails breed in autumn and spring. This usually means drenching all sheep at risk in February and June. (Fasinex® is recommended for all fluke treatments because it is more effective against immature fluke. Resistance to Fasinex® has been confirmed on properties in the Pyramid Hill area of Victoria and is becoming more common in the summer rainfall areas of NSW).

- If only a small part of the farm is affected, then excluding stock from these wet areas may be a simple and effective way of controlling liver fluke.

- Where pasture contamination with the infective stages of liver fluke is very high, tactical treatments may have to be given at 6 - 8 weekly intervals. For mobs grazing known problem paddocks or areas, the best control is to:
  - drench sheep for fluke before they go onto the area,
  - graze this area for no more than eight weeks, and
- drench with a fluke drench when sheep are removed.

- A correct 5- or 6-in-1 vaccination program is also important to reduce the risk of Black disease.

**Drench Resistance**

- Despite the large number of drench brands, there are only three chemically different groups of broad-spectrum drenches for sheep - the white (‘BZ’), clear (levamisole) and macrocyclic lactone (MLs – ivermectin, abamectin & moxidectin).

- In Victoria, at least 90% of flocks have detectable resistance to the two older groups of drenches (the white and clear groups).

- Using these two older drench groups at the same time (BZ-Lev combination drenches) will give increased effectiveness, but this combination is still not good enough to be used as a summer drench in about half Victoria’s sheep flocks.

- ML resistance is being detected in Victorian flocks, but has been much a slower to develop than in other winter rainfall areas that have a more prolonged or extreme dry summer period (eg. Western Australia and Kangaroo Island).

- The reason for this difference is related to the proportion of free-living stages of the worm that survive over summer. WA & Kangaroo Island have more extreme Mediterranean climates, allowing far fewer free-living stages to survive through to the next autumn break than is the case in Victoria. This means that, compared to southern Victoria, a much greater proportion of the next winters’ worm population will be derived from survivors of a summer treatment.

- In support of this, larvae of *Ostertagia* spp. are better able to survive hot dry conditions and, without exception, these have been the worms resistant to the MLs in the winter rainfall areas of Australia. The free-living stages of *Trichostrongylus* spp. are far less tolerant of drying out, and no ML resistance has yet been reported in *Trichostrongylus* in Australia.

- An extension of this explanation is that parts of northern Victoria (eg. the Wimmera-Mallee and North-east) will have a similar risk of ML resistance as WA and Kangaroo Island. There has been no recent series of drench resistance tests in these areas to see if this is the case.

**Testing for drench resistance**

The faecal egg count reduction trial (FECRT) and DrenchRite™ are the two most common tests, costing around $500 and $200, respectively.

The DrenchRite™ test is easier to do on the farm – simply collect 250 g of fresh dung from a mob of sheep with an egg count over 200 epg and send it to a laboratory that can do the DrenchRite™ test. However, it can’t assess the effectiveness of the naphthalophos combinations or the ML group.

The FECRT is more difficult to set up on the farm - there are a lot of common errors that can make the test result useless or suspect. A typical test needs 6-8 groups of sheep, each with 12-14 sheep (faecal samples are collected 10 days after drenching, from 10 sheep in each group).

The following groups should be included in a FECRT:

- Untreated sheep (‘Controls’)
- An ML group (preferably 2 groups - one given a full dose of ivermectin, the other a half-dose)
- Combination of levamisole and BZ
- 2 Naphthalophos (Rametin®) groups – 1 combined with BZ, another with clear (levamisole). These are a useful alternative summer treatment in up to two-thirds of flocks.
Ivermectin is the best compound to test for ML resistance in an FECRT because it is less effective against ML resistant worms than either abamectin or moxidectin (although the ML resistant worms are still resistant to these drugs).

Closantel (Seponver®) is a ‘narrow-spectrum’ drench used to control Barbers’ Pole worm in NSW, and there is now widespread resistance to this drug in the Barbers’ Pole areas. However, very little closantel has been used in Victoria, hence Barbers’ Pole worms in Victorian flocks are usually sensitive to it (unless they are resistant strains imported from NSW!).

Wormplan Control Strategies

The aim of a worm control program is to reduce the productivity losses due to worms as much as possible with the fewest drenches. Wormplan is based upon the following key points:

1. Grazing management to reduce the need for drenching - grazing ‘susceptible’ sheep (eg. weaners & maiden ewes) on ‘low risk’ paddocks, weaning Merinos lambs at the correct age onto prepared paddocks.
2. Testing for drench resistance every 2-3 years.
3. Correct timing of the 1- or 2-summer drenches (‘strategic’ drenches).
4. Monitoring worm egg counts before drenching at other times.
5. Avoiding under-dosing when sheep are drenched.
6. Avoiding introducing resistant worms in sheep brought onto the farm.

Most Victorian sheep farmers are using parts of this program, but could improve their worm control by monitoring worm egg counts more often and better use of grazing management.

1. Grazing management
The sheep most susceptible to worms are weaners and lambing ewes, especially maiden ewes.

Paddocks that are low risk are:
- crop stubbles, fodder crops, hay aftermath and new pastures, or
- those that since the autumn break were:
  - not grazed at all,
  - grazed only by cattle, or
  - grazed only by dry sheep over two years old.

Spelling a paddock for any length of time after the autumn break, during autumn, winter or spring, does not reduce the number of infective larvae on the pasture, ie. once a paddock becomes heavily contaminated with worm larvae, it remains ‘high risk’ until after next summer.

Paddocks that are high risk are:
- those that have had lambing ewes in them since the previous summer,
- those grazed by weaners since the previous summer, or
- those grazed by maiden ewes since the previous summer.

Lambing ewes contaminate pastures heavily with worm eggs, because each worm produces more eggs. Presumably, this rise in egg output is an adaptation by the worm to provide lots of infective larvae to the new crop of lambs

“Smart Grazing”
Smart Grazing (link to Article 3) is a reliable way of reducing worm problems in spring-born weaner Merino sheep during their first winter grazing period. It is designed to offset the increased worm pick-up in wet summers that substantially reduces the effectiveness of the ‘double summer treatment strategy’ in about 1 of 3 summers in southern Victoria.
2. Testing for drench resistance – link to above

3. Correct timing of the 1- or 2-summer drenches
Many farmers tend to give the first summer treatment a bit too late. Some benefits of ‘summer’ strategic drenching are lost as the time between the drench and the next autumn break becomes shorter.

Ideally, the first summer drench should be given between late October (northern Victoria) and early December (the cooler, higher rainfall areas in the south), depending on the local climate. Generally, the later the ideal spring lambing time for a locality, the later will be the best time for the first summer treatment.

4. Monitoring worm egg counts
‘Wormtest’ monitoring gives an estimate of the number of adult female worms present, particularly in weaner sheep in their first winter grazing period. Some times for Wormtest monitoring include:
- a selection of wethers and ewes before the second summer drench (to assess if the second treatment is needed, and also what worm pickup has occurred since the first summer drench). This is more important in southern Victoria – choose the youngest and oldest age groups;
- Weaners 3-4 weeks after the autumn break, then at 4-6 week intervals until August;
- Ewes 4 weeks before lambing, especially maidens and those in poorer condition

5. Don’t under-dose
Weigh sheep before drenching and set the dose to the heaviest in the mob. If necessary, draft the mob into lighter and heavier groups to give a more accurate dose range.

6. Avoid introducing resistant worms
When sheep are brought onto a farm, they bring their worms with them. At least 90% of flocks have drench resistance, and so it’s most likely that purchased sheep will have drench resistant worms. Therefore, introduced sheep should be treated with an ML drench plus either a BZ-Lev combination or Rametin® R, then placed onto a fairly wormy paddock to dilute (hopefully the very few) worm eggs passed after this treatment. Alternatively, monitor worm egg counts 10 days after a more simple treatment to check that they are zero.

Contacts For Advice On Worm Control And Laboratory Testing In Victoria

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Further Reading

3. ‘Getting on top of dags’; Rural Research No. 169 (Summer 1995/96), pp 16-18
4. ‘What does 250 epg mean?’; Mackinnon Project Newsletter, June 1999
5. ‘Get smart – go smart grazing’; Mackinnon Project Newsletter, September 1999
6. ‘Breeding for increased resistance to worms’; Mackinnon Project Newsletter, November 1999
7. ‘Pasture management and worm control’; Mackinnon Project Newsletter, September 2000
8. ‘Macrocyclic lactone resistance in Western Victoria’; Mackinnon Project Newsletter, May 2001