Internal Parasite Control in Sheep

Reference Manual

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Acknowledgements

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Course aim

The aim of this course is to monitor and manage worm populations of your sheep flock to improve production levels. This will be done by:

- The monitoring of worm populations using worm egg counts to detect infestations early.
- Becoming competent at conducting a worm egg count test and interpreting the results.
- Regular drench resistance tests to determine which drenches are effective on the property.
- The use of WormBoss to aid decision making.

Setting the scene

Worms cost the Australian sheep industry an estimated $369 million per annum, more than any other major sheep health issues (see Figure 1 and Table 1). It is estimated that the Australian sheep industry faces a $700 million parasite bill by 2010 as drench resistance rises and production losses accelerate (McLeod 1995). Drench resistant worms are increasingly prevalent and are becoming harder to manage. For most sheep producers, sustainable management and control of sheep worms is essential for their future prosperity.

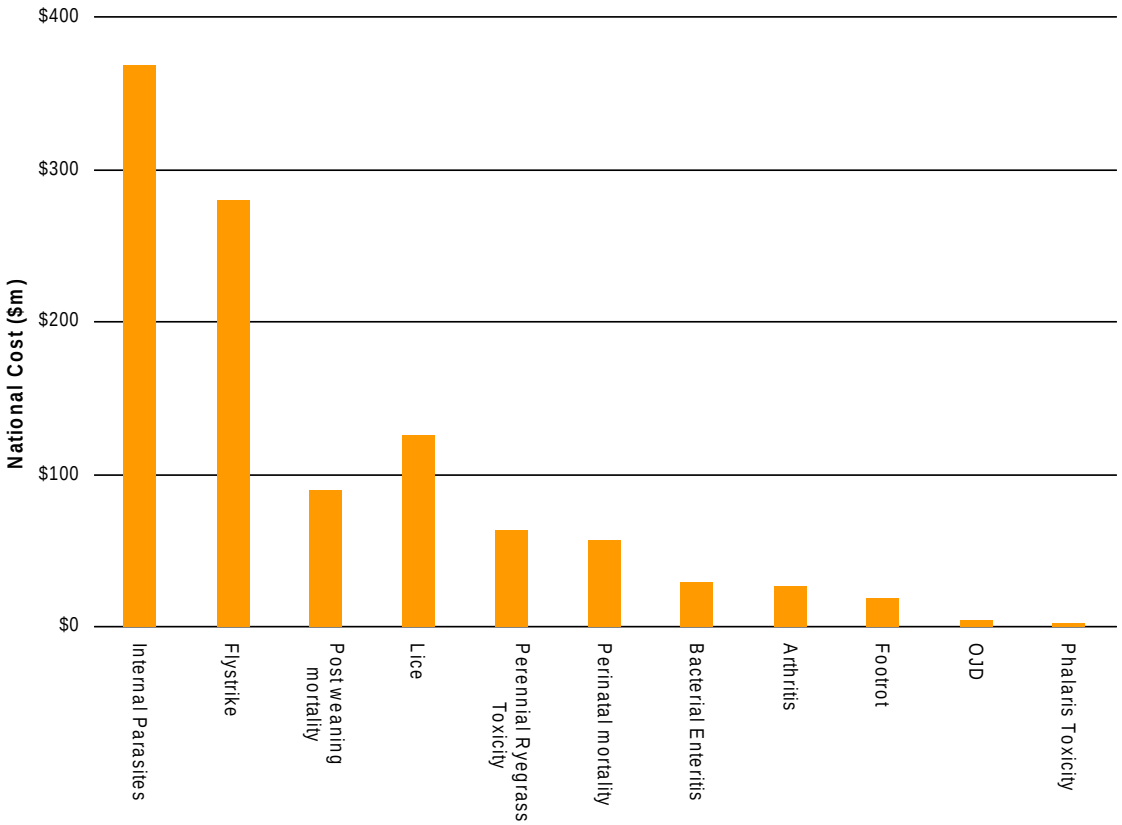


Figure 1. National cost ($million) of major sheep health issues in Australia. (Source: Holmes et al. 2006)

Table 1. National cost ($million) of major sheep health issues in Australia. (Source: Holmes et al. 2006)

Health issues	**National costs ($million)**
Internal parasites	369
Flystrike	280
Lice	123
Post-weaning mortality	89
Ryegrass toxicity	64
Perinatal mortality	57
Bacterial enteritis	29
Arthritis	26
Footrot	19
OJD	4.5
Phalaris toxicity	2

Types of internal parasites

Parasites that invade sheep are generally classified into groups according to anatomical features and their life cycles.

Essentially, parasites can be broken down into three different groups:

a) Strongyles or Round worms
b) Cestodes or Tapeworms
c) Trematodes or Liver flukes

Round worms (Strongyles)

The round worms (Strongyles) are the major cause of production losses in sheep. These worms generally invade the abomasum (true stomach) or the intestines, with the exception of the lung worm, which invades the lungs (see Table 2).

Table 2. Examples of round worms and where they are located in ruminants. (Source: Cole 1980)

Site	Round worm scientific name	Round worm common name
Abomasum	*Haemonchus contortus* *Teladorsagia circumcincta* *Trichostrongylus axei*	Barbers Pole Brown Stomach Stomach Hair
Small intestine	*Trichostrongylus colubriformis* *Trichostrongylus vitrinus* *Nematodirus spathiger* *Cooperia curticei* *Bunostomum trigonocephalum* *Strongyloides papillosus*	Black Scour Black Scour Thin Necked Intestinal Small Intestinal Hook Worm Strongyloides
Large intestine	*Trichuris ovis* *Oesophagostomum columbianum* *Oesophagostomum venulosum* *Chabertia ovina*	Whip Worm Nodule Worm Large Bowel Large Mouthed Bowel
Lungs	*Dictyocaulus filaria* *Muellerius capillaries*	Large Lung Small Lung

In summer dominant rainfall areas the most important round worms are Barbers Pole (*Haemonchus contortus*) and Black Scour (*Trichostrongylus spp*.).

Whilst in winter dominant areas the Brown Stomach (*Teladorsagia spp.)* and Black Scour (*Trichostrongylus spp*.) worms are of major importance. Lung worms are also more prevalent in the cool winter rainfall areas.

In the uniform rainfall areas all three worm species occur, but their level of importance will depend on the timing of the rain e.g. Barbers Pole outbreaks can occur in wet summers.

Black Scour worm Barbers Pole worm

Figure 2. Examples of Black Scour worm (*Trichostrongylus colubriformis*) on the left and Barbers Pole worm *(Haemonchus contortus*) on the right. (Source: WormBoss website, image supplied by Associate Professor Nick Sangster, University of Sydney).

Life cycle of round worms

The life cycle of round worms is relatively simple, as shown below. The adult phase occurs within sheep and the eggs and larvae occur outside on the ground and on pasture.

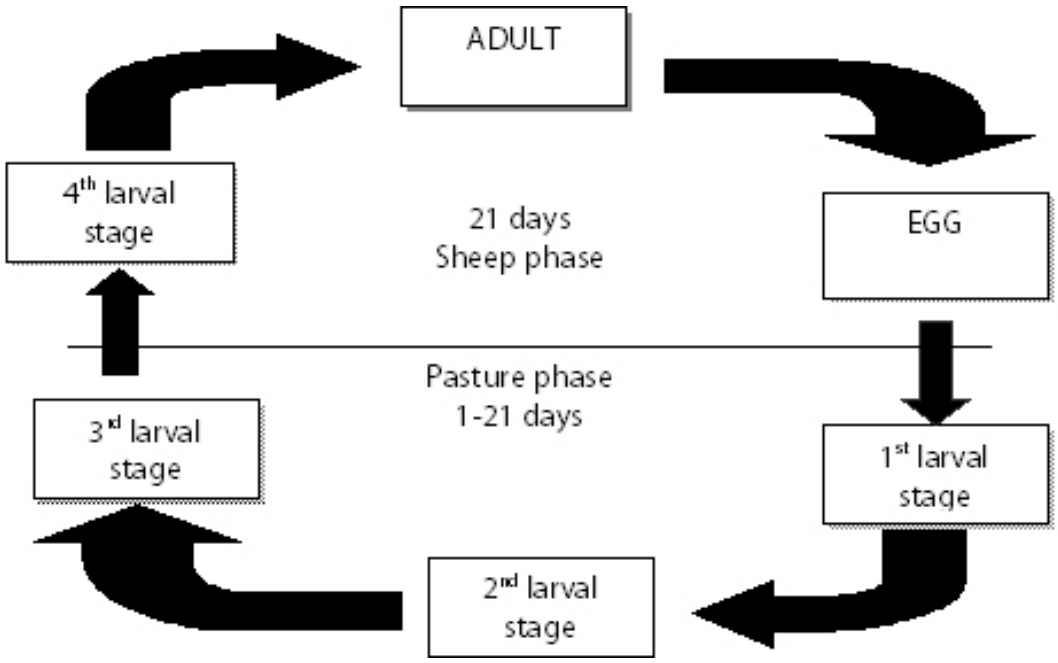


Figure 3. Life cycle of round worms. (Source: Cole 1980)

The Pasture Phase

Larvae are immature worms that are very small in size. Larval stages 1 to 3 occur on pasture and are dependent on temperature and moisture levels. This may influence their rate of development from one to three weeks duration.

Larval stages 1 and 2 are independent, feeding on bacteria from faeces and the environment. They are affected by hot, dry and windy conditions. The third stage has a protective coat around it from the larval second stage moult and lives off bacteria and yolk contents from this stage. See Figure 4 shows third stage larvae in a dew drop waiting to be ingested.

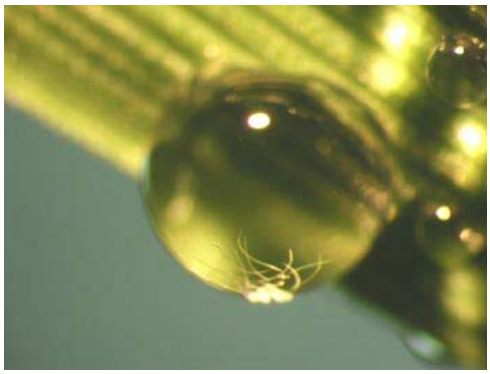


Figure 4. Worm larvae in a dew drop waiting to be ingested. (Source: WormBoss website, image supplied by Dr Russ Hobbs, Murdoch University).

The Animal Phase

Once ingested into the sheep the larvae develop from the infective third larval stage to the fourth larval stage and then into adults to complete the life cycle. On average it takes 21 days from ingestion until worm eggs appear in the faeces.

Epidemiology

Temperature and moisture are the two environmental factors that are critical for the survival of worm eggs on pasture and the subsequent larvae that hatch from them. Because eggs require both humidity and warmth to hatch they can wait for the right conditions using their protective coat. Most round worms require average daily temperatures of 10°C minimum (except Barbers Pole worm which requires 15°C) and humidity at grass level of 50% to initiate hatching. As a general rule, adequate moisture is provided by 50mm or more of rain in the cooler months and 75mm in the hotter months. The warmer the temperature the more quickly the worm eggs hatch.

Life cycle of lung worms

Lung worm eggs are laid in the airways and coughed into the mouth where most are swallowed. The larvae then pass onto pasture through the faeces where they are ingested and migrate via the bloodstream to the lungs. The larvae penetrate the bronchioles in the lungs and mature here.

Tapeworms (Cestodes)

The most common tapeworm of sheep is called *Moniezia expansa*. It is found in the intestine and grows to around one metre long. Despite their size, tapeworms are generally regarded as relatively harmless. There is no definitive or confirmed evidence in scientific literature that tapeworms cause any ill-effect to sheep or that removing them gives a beneficial effect.

The other tapeworms of major importance are the hydatid parasites, *Echinococcus granulosis* and *Taenia ovis*. Tapeworm segments can be visible in sheep dung as a white rice grain-like appearance. Adult worms can also be seen on post-mortem or when expelled into the

environment, typically in yards or other areas where sheep are concentrated. Tapeworm eggs in sheep dung samples can be detected using the standard worm egg count procedure.

Liver flukes (Trematodes)

Liver fluke (*Fasciola hepatica*) has a very complex life cycle (see Figure 5) and a fresh water snail is required as a host for part of it. Liver fluke are brown flat leaf shaped parasites, one to two centimetres in length, see Figure 6. Adult liver fluke live in the sheep's bile ducts, laying eggs that pass into the intestine and out in the dung. The eggs hatch into larvae called miracidia that infect particular water snails. The miracidia then multiply inside the snail into another larval stage called metacercariae. These emerge from the snail and attach to vegetation that is then eaten by the sheep. In the sheep's small intestine they become immature fluke which then migrate through tissues for a few days until they reach the liver. The fluke then spend some weeks in the liver before settling in the bile ducts, where the cycle starts again.

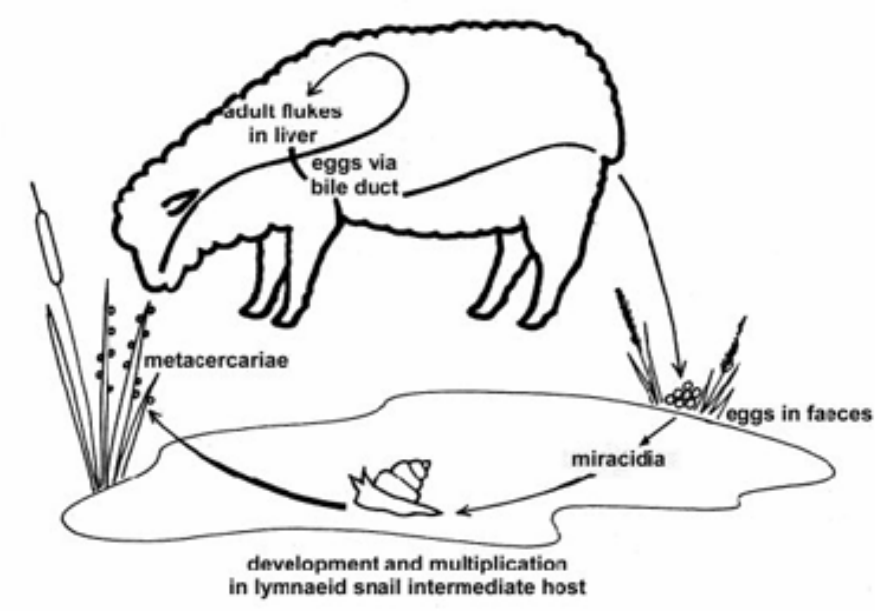


Figure 5. The life cycle of the liver fluke. (Source: WormBoss website)

Figure 6. Example picture of a liver fluke. (Source: WormBoss website)

Parasite damage to sheep

Parasites cause some level of production loss to sheep whenever they are present. They cause tissue damage, appetite suppression, scouring and competition for protein.

Tissue damage

The damage to organs is caused by migration of the parasite through the various tissues. Damage may only be temporary but sometimes permanent problems occur. Often tissue damage leads to invasion by foreign bacteria such as the clostridials. Damage to tissues requires energy and protein to repair these areas, which diverts energy from production of meat, wool and milk, etc. Scarring from damage may reduce organ function as well.

Appetite reduction

Sheep affected by worms show reduced appetite for pasture and studies have shown reduction in feed intake of up to 10% by infections caused by Black Scour and Brown Stomach worms.

Scouring

Ruminants, particularly sheep, display black faecal staining on the breech area due to liquefying of the intestinal contents caused by irritation of the bowel by parasites accessing nutrients. This causes increased mucus discharge into the faeces and the gut becomes more motile, i.e. contents move through the bowel more quickly, initiating the scour symptoms. This translates into reduced nutrient absorption, reduced production and in sheep, wool contamination and dag formation. This in turn predisposes sheep to blowfly strike, which is extremely costly to control.

Competition for protein

Round worms seek out blood supply, usually vessels in the lining of the intestine. They access protein and nutrients for their own metabolic processes. Barbers Pole, Hook and Large Mouthed Bowel worms cause anaemia due to their ability to remove red blood cells as well as proteins, which can lead to ill thrift in infected animals. With sheep, competition for protein will also affect wool production, milk production, muscle development, fertility and metabolic processes. In all ruminants the immune system may also be affected seriously. Sheep generally display the effects of parasite invasion in a number of the above forms.

Overall production effects

Parasites compete for energy and protein, which are very important for production as meat, wool and milk require large amounts of protein to be synthesized.

The effects of parasite competition will be seen in the reduction of:

- fertility
- milking ability
- meat production
- wool production
- wool soundness
- immunity.

This causes ill thrift in younger animals, particularly lambs and weaners. Reduced milk production reduces growth rates in lambs, survival of young stock and immunity from poor colostrum production. The milk production drop is replaced by earlier grass ingestion, which can exacerbate the parasite problem by taking in many more larvae.

Introduction to WormBoss

(Source: WormBoss website)

Worms cost Australian sheep producers more than any other disease. Drench resistant worms are increasingly prevalent and becoming harder to manage. For most sheep producers, sustainable management and control of sheep worms is essential for their future prosperity.

WormBoss was developed by the Australian Sheep Industry Cooperative Research Centre (Sheep CRC) and Australian Wool Innovation Ltd (AWI) to help producers meet these challenges.

WormBoss represents the national knowledge on sheep worms and their management. It has been assembled by leading parasitologists, researchers, extension officers, consultants, drench manufacturers and drench resellers. These are the people who made WormBoss.

WormBoss recommends four general management practices:

- Monitor worm populations using worm egg counts to detect infestations early.
- Do regular drench resistance tests so you know which drenches are effective on your property.
- Maximise the use of non-chemical management strategies.
- If you are unsure of anything—seek professional advice.

As you use WormBoss, you will see how you can use these practices to reduce costs, improve sheep health and productivity and increase profitability.

Website address: www.wormboss.com.au

Topics addressed on the WormBoss website:

- Ask the Boss (an online tool to assist the decision of whether to drench)
- WormBoss news (state updates)
- Worm management
- Know your drench
- Know your worms
- Know your sheep
- Know your advisor
- Feedback

Alternatively, if the topic you are after is not on the menu, a search box is located on the right of the screen where you can type the subject and click on the SEARCH button.

Worm egg counting

(Source: WormBoss website)

Monitoring worm populations by worm egg counting is one of the most useful worm management tools a sheep producer can use (see Figure 7).

Note that this is often referred to as faecal egg counting (FEC) (especially in eastern Australia), but in recent years it was decided that this should universally be called worm egg counting (as the worm eggs are always in faeces anyway).

A worm egg count (WEC) is a count of the number of worm eggs in a sample of sheep dung. The result is usually expressed as 'eggs per gram' (epg) of dung with the main results often divided between Strongyle (including most of the significant worm species such as Barbers Pole, Brown Stomach and Black Scour worms) and *Nematodirus* eggs.

The actual number at which the worms become a problem varies with the worm species present. For example, a worm egg count of 500 eggs per gram (epg) of Barbers Pole worm is not as significant as 300 epg of *Trichostrongylus vitrinus*, one of the Scour worms.

Conducting a larval culture, which will identify all the species present in the sample, can further refine this result.

Worm egg counts are an important practical tool to estimate the burden of adult worms in monitored sheep. A worm egg count is a much more accurate diagnostic tool than visual assessment and will identify an emerging problem long before any visual symptoms appear.

Worm egg counts are a useful guide to check the overall worm status of a mob to decide if treatment is necessary, to decide if previous treatments were effective or to assess the levels of worm contamination being put onto paddocks. Individual sheep worm egg counts can also be used as the basis for selecting worm resistant sheep.

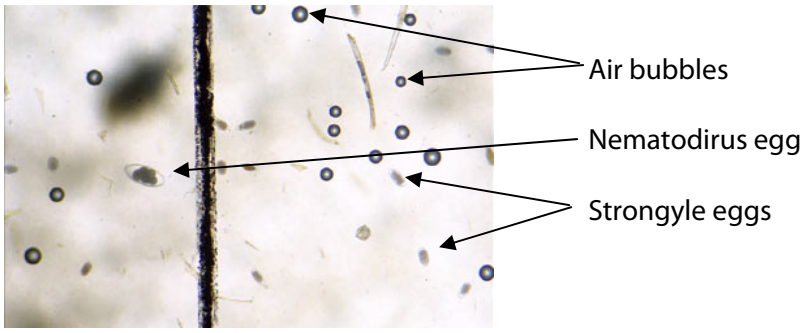


Figure 7. View of worm eggs (Source: WormBoss website, image supplied by Dr R Woodgate, Western Australia Department of Agriculture).

Collecting the dung sample

(Source: WormBoss website)

There are two ways dung samples can be collected for worm egg counts—freshly deposited dung off the ground or directly from the rectum of the sheep.

If collecting for normal monitoring of a mob, the sheep can be quietly held against a fence for 10-20 minutes, allowed to walk off and fresh dung collected off the ground, taking care not to collect too much dirt and other debris with the sample.

Often sheep are 'on camp' around lunch time or early afternoon and this is a good time to quietly approach the mob, get them to stand for a short time before moving them off camp and then collect samples from the fresh dung piles.

Faecal samples can be collected directly from the rectum of individual sheep with a gloved finger. This is the preferred technique when it is important to have individually identified samples, such as when selecting animals for worm resistance and when collecting post-treatment during a Faecal Egg Count Reduction Test (FECRT or resistance test) so that exact individuals or groups of origin are known.

The collected samples should be sent to the laboratory as soon as possible after collection.

Worm typing (larval culture and differentiation)

(Source: WormBoss website)

It is difficult to differentiate the eggs of many common species of sheep worms during a worm egg count. When it is important to know exactly which species of Strongyle worms are present (e.g. when the presence of Barbers Pole worm is being checked or after a drench resistance test) a worm larval culture and species differentiation is carried out.

The collected dung remaining after the worm egg count has been completed is bulked together in a jar, mixed with a substance called vermiculite to help aerate the dung and then incubated in an oven for a few days to allow the eggs to hatch and develop into worm larvae. Trained laboratory technicians can then tell the species of the worm larvae (see Figure 8) and give a result describing the proportion of each worm species in the dung samples that were from the different worm species.

Figure 8. Worm larvae (Source: WormBoss website, image supplied by Dr R Woodgate, Western Australia Department of Agriculture).

The Worm Egg Count (WEC)Test

1. Aim of procedure

The procedure determines the number of eggs per gram of faeces from the sheep from a sample of known weight mixed at a specific dilution and counted in a slide chamber of known volume. The modified McMaster technique (Whitlock 1948) is currently the most common method for determining worm egg counts.

2. Materials required to undertake worm egg count

Collection of samples

- Suitable containers are required for faeces
- Surgical gloves
- Recording sheet and pens

Weighing

- 60ml volumetric container
- Scales suitable to weigh 2g samples or appropriate volumetric container
- Ten faecal samples

Slide Preparation

- Spatula for mixing samples
- Mixing bowl
- Small strainer
- Pipette or small syringe
- Saturated salt solution (see note)
- Compound microscope with x4 objective and x10 eyepiece (please read notes on microscopes on page 18 before using).
- Worm egg counting slide
- Recording sheets
- Fresh water for rinsing equipment
- Paper towel

NB. A saturated salt solution (SSS) is a solution that cannot dissolve anymore salt. To obtain a saturated salt solution simply add salt to a container of water until no more salt will dissolve, and small crystals are left on the bottom of the container.

The SSS causes eggs to float to the surface of the liquid. This enables the eggs to be counted under the microscope. Samples that have been prepared with SSS should not sit for more than 30 minutes before counting as the salt may destroy the eggs.

3. Method

- If collecting dung from the rectum, lubricate your gloved index finger with soapy water first to make insertion easier.
- Gently hook dung out with the finger taking care not to tear the rectal wall.
- Weigh 2g of faeces from each sample and place into the mixing bowl.
- Add the 60ml of saturated salt solution over the faeces and mix using the spatula.

- Pour the mixture through the strainer to remove excess fibrous material.
- Immediately before pipetting the liquid, stir the sample in a North-South, East-West motion, not in a circular motion as the eggs will concentrate in the centre rather than evenly throughout the mixture.
- Run water through the counting chambers of the slide, then shake remaining out (this wets the surface and allows the mixture to enter easily).
- Fill the chambers of the slide from right to left and with the "verandah" of the slide facing away from the operator.
- Allow about 1 minute between preparation and counting for the eggs to float to the top of the slide.

4. Counting

- See Egg Identification Sheet (on page 17) as an aid to identify different worm egg species.
- The eggs that might be seen are:
    - Strongyle type (includes *Trichostrongylus, Haemonchus, Teladorsagia, Cooperia, Bunostomum, Oesophagostomum, Chabertia* and these are not distinguishable from each other*)*
    - *Nematodirus* (similar to strongyle, but much larger, more airspace and fewer cells).
    - *Coccidia*
    - *Moniezia*
    - *Trichuris*
    - (other eggs require different preparation techniques).
- Place the slide on the microscope with the "verandah" facing away from the operator. Use the fine focus knob to bring the line of the slide into sharp focus.
- Begin counting using the lines as a guide.
- For each sample, count and record the numbers of eggs seen.

5. Calculations

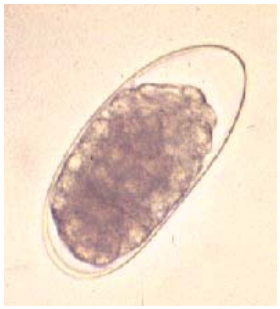
- The total number of eggs per gram of faeces is calculated using the following equation:

$$\text{Number of eggs/gram of faeces} = \frac{\text{number of eggs counted x total volume of mix (ml)}}{\text{volume of counting chamber (ml) x wt of faeces in mix}}$$

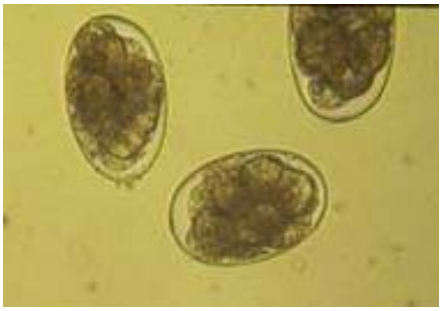
6. Interpretation of results

- Log onto the WormBoss web site: www.wormboss.com.au
- On the Home Page there is a menu to the left of the screen (under the WormBoss logo). The very first topic on this menu is "Ask the Boss". Click on "Ask the Boss" and read this page. In the summary it will tell you what is required to 'submit' your query and will then generate a 'report'.
  NB "Ask the Boss" states that it will help when you are talking to your professional advisor (who will know more about your individual situation) and not waste time and money discussing basic issues. It is a helping guide and not necessarily a solution.
- Then click on "Consult the Boss" located at the bottom of the screen and follow the prompts.

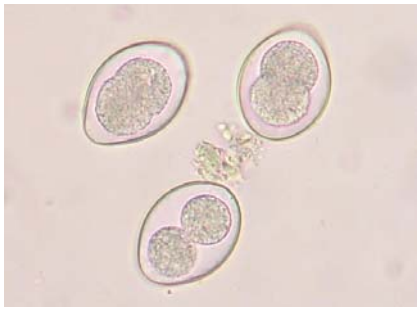
Egg Identification Sheet



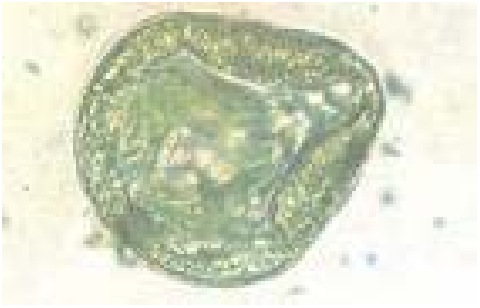
1. Trichostrongylus (Black scour worm)



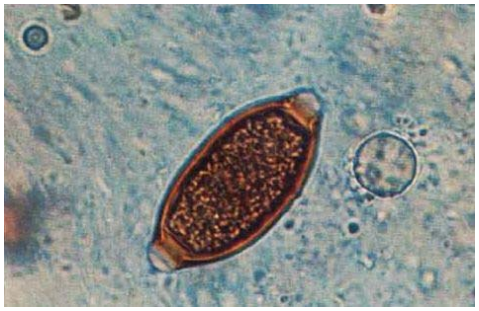
2. Haemonchus (Barbers Pole worm)



3. Coccidia

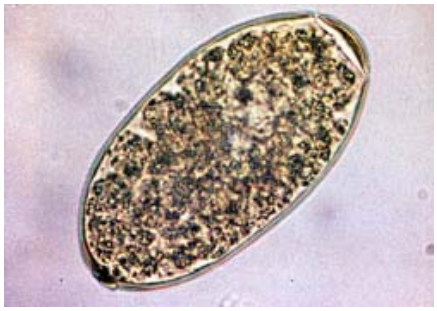


4. Moniezia (Tapeworm)

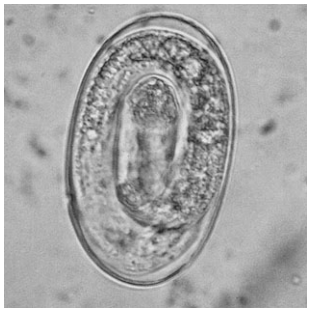


5. Trichuris (Whipworm)

6. Nematodirus (Thin necked Intestinal worm)



7. Fasciola (Liver Fluke)



9. Dictyocaulus (Lungworm)

The images on this page were sourced from:

1. www.stanford.edu/class/humbio103/ParaSites2005/Trichostrongyliasis/agent.htm
2. www.sheepandgoat.com/HairSheepWorkshop/parasitism.html
3. commons.wikimedia.org/wiki/Image:Coccidia.JPG
4. www.medata-systems.co.uk
5. w3.ufsm.br/parasitologia/arquivospagina/ovosdebovinos.htm
6. www.stanford.edu/class/humbio103/ParaSites2005/Trichostrongyliasis/agent.htm
7. cal.vet.upenn.edu/projects/parasit06/website/lab6.htm
8. www.medicalvetonline.com.br/atlas.php

Microscopes

Parts of the microscope:

- Barrel with the lens and eyepiece.
- Stage for holding the slide that is able to be moved manually.
- Moving stage—this can be attached to the stage. By using the turning screw handles it allows you to have more control when moving the slide.
- Light source to project light through the area being viewed. The denser the object the more light is required and extra light is needed with higher magnification.
- Distal end of the barrel—has lenses of different magnification that can be rotated around the head. For worm eggs counts, the magnification used is 40x. There should be no need to adjust the focus when rotating the lens for different magnification.

Use of the microscope:

- Extreme care should be taken when using a microscope. It is a precision instrument with fragile parts and is an expensive piece of equipment.
- Start at the lowest magnification (on the microscope head).
- Rotate the focus wheel before using to see which direction lowers/raises the lens and microscope head. Enough space should be left for the slide to fit easily on the stage.
- To focus use the coarse focus first then fine tune with the finer focus wheel.
- DO NOT ALLOW the microscope head to come in contact with the slide as it may break the slide.
- Rest your eyes regularly—this will help you to concentrate on the subject.

Care of the microscope:

- Lens—use only clean tissue paper when cleaning the lens. Any rough cloth or cleaning agent may scratch the lens.
- Microscope—always clean after use, especially after using salt solution as it causes corrosion, making the parts immoveable.
- Stage—wipe the stage lightly with an oiled tissue.
- Storage—keep the microscope covered or store in a dust free container immediately after use.
- NB. Always clean equipment immediately after use. Never leave the cleaning until beginning your next job—this is very unprofessional and may cause damage to the microscope over time.

Drench resistance

(Source: WormBoss website)

In most sheep districts of Australia, knowing the drench resistance status of your property is essential if you are going to be able to effectively manage worms. If you do not have any drench resistance information, you should seek professional advice on how to have it done as soon as possible.

Theoretically, drench resistance occurs once a population of a species of worm can survive a dose of a drench that would have previously killed it. Worms killed by a drench are said to be susceptible to the treatment.

The currently accepted industry definition of drench resistance, as measured in a Faecal Egg Count Reduction Test (FECRT), is a reduction in worm egg count of less than 95 percent.

This definition is important to understand, because at this level of efficacy, drench resistance would most likely not be causing clinical worm problems, such as scouring, obvious weight loss or anaemia. However it could be associated with loss of production. By the time that obvious drench failure occurs then resistance is very well established within the worm population. This is one of the reasons why it is unlikely that resistance can be reversed, even if the drench group is not used for a long period of time. Preventing or reducing the onset of drench resistance is the best option.

Drench resistance is genetic (controlled by genes). Resistance to each group of drenches is controlled by different genes, meaning that resistance develops to each drench group separately. Being a genetic trait, drench resistance is also heritable (can be passed on from one generation of worms to the next).

Initially, resistant worms are rare in a population of worms. When a sheep is treated the resistant worms survive and, if they find a mate, can reproduce. The resultant offspring are resistant and if they survive as larvae on the pasture and infect another sheep they will make up a greater proportion of the worm population than their parents did. Over time, and with continued treatment, the overall resistance level to the treatment within the worm population increases.

The rate of development of drench resistance can be influenced by many factors such as:

- The chemical group and persistency of the product involved
- The frequency of treatments
- The worm species involved
- Environmental factors such as climate.

How common is drench resistance?

Resistance to sheep drenches is widespread and probably 90 percent or more of farms have a resistance problem. Following is an overview of the recent resistance situation, with particular reference to New South Wales. (Source: Love 2005)

Table 3. Overview of drench resistance

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, 'mectin') drenches: Avermectins (ivermectin, abamectin) Milbemycins (moxidectin)	Becoming more common. About 60% of sheep farms in WA have ML-resistant *Ostertagia*. ML-resistance in *Haemonchus* in northern NSW and southern QLD is becoming more common (possibly 30–60% of farms). ML-resistant *Ostertagia* occurs on up to 30% of farms in southern NSW and other non-seasonal to winter rainfall areas of south-eastern Australia.
Naphthalophos (Rametin®, Combat®)	One recorded case in QLD.
Closantel	Resistance in *Haemonchus* is common in northern NSW and south east QLD. Some isolates are also ML-resistant. Small number of resistant strains of liver fluke in Australia.
Triclabendazole (Fasinex®, Flukare®, Flukex®)	Small number of resistant strains of liver fluke in Australia.

* Drench efficacy < 95 percent. Prevalence of ML-resistance: these estimates refer to avermectins (ivermectin, abamectin) resistance. The prevalence of resistance to moxidectin, which is more potent, is currently somewhat lower.
(Source: Love, 2005)

A time line of drenches and drench resistance

The following outlines the history of drench release and the development of drench resistance in sheep worms. (Source: Love 2005)

Table 4. Timeline of drenches and drench resistance

Year	Drench release	Drench resistance discovered/reported
1961	Thiabendazole (TBZ)	
1966		TBZ (*Haemonchus*) NSW
1968	Levamisole (LEV)	
1972	Second generation BZs	
1977		1st New England survey: 18% of farms had TBZ resistant *Haemonchus*.
1979		LEV (*Ostertagia*) – NSW, LEV and BZ – VIC.
1982	Closantel	
1984	(WormKill launched July, northern NSW)	2nd New England survey: LEV and BZ resistance widespread (*Haemonchus, Trichostrongylus, Ostertagia*)
Dec 1985	(DrenchPlan launched southern NSW)	
1987		Ivermectin (*Haemonchus*) – South Africa and South America. Closantel (*Haemonchus*) – northern NSW.
1988	Ivermectin (Ivomec®) (WormPlan launched – Vic)	
1989	(Proprietary) BZ + LEV combinations	
1987–1991		Combination (BZ + LEV) resistance common northern NSW.
1990	Albendazole Capsules	
1993		Ivermectin (*Haemonchus*) – northern NSW.
1994		Ivermectin (*Ostertagia*) WA. Ivermectin and moxidectin (*Ostertagia* – goats from NZ) – NSW.
1995	Moxidectin (Cydectin®) Naphthalophos re-released (Rametin®; recently Combat®)	
1996		Closantel (*Haemonchus*) prevalent, northern NSW.
1997	Ivermectin capsule	Several ML-resistant strains (*Haemonchus*) including one also resistant to closantel – northern NSW.
March 1998	(WestWorm/FarWestWorm launched)	
2000		About 40% of WA farms have ML resistance. ML-resistant *Haemonchus* becoming more common in northern NSW/southern QLD. First reports of ML resistance (*Ostertagia*) in sheep in southern NSW.
2001		Multi-drug, including moxidectin resistant isolate of *Haemonchus* found in northern NSW.
2003–2005		About 60% of WA farms have ML-resistant *Ostertagia* and about 30–60% of northern NSW farms have ML-resistant *Haemonchus*. ML-resistant *Ostertagia* becoming more common in southern NSW and other non-seasonal or winter rainfall areas of Australia.
2005		Moxidectin (and other) resistant *Haemonchus* and *Trichostrongylus colubriformis*; goats, south-eastern QLD.
March 2005	(WormBoss launched www.wormboss.com.au)	

Drench resistance testing

(Source: WormBoss website)

When planning worm treatments it is critical to know the efficacy of the various drench options on your property. Knowing which drenches are effective on your property is essential if you are going to choose the correct drench to kill the worms present in your sheep.

The main way to assess drench efficacy is using a drench resistance test or faecal egg count reduction test (FECRT). You should contact your local veterinarian, sheep consultant or departmental sheep officer when planning this test to ensure that the work involved yields the most useful results possible. They will give good advice on mob and drench selection for the test and other local requirements such as the number of animals and faecal sample collection techniques that are necessary.

A drench resistance test is best carried out on a group of wormy, young, undrenched sheep such as lambs approaching weaning age. If testing is only possible using sheep older than about six months of age then seek professional advice first to modify the methodology used.

An initial worm egg count of the selected sheep is important before the main test is started to check that sufficient worms of the necessary species are present to make the test worthwhile. A worm egg count of at least 300 eggs per gram (epg) is the general rule, but check this with your local veterinarian or sheep consultant. Once a suitable mob of test animals has been found they are randomly drafted into groups of 15 animals.

One group is randomly allocated to each of the drench groups to be tested and an additional group is needed to provide untreated control animals. Sheep should be adequately identified to their groups and then receive an individual dose of their respective products. This is carefully calculated and checked on the heaviest individual within each group. Sheep in the control group remain untreated. After treatment all of the sheep can be run together or as part of any other mob of sheep until it is time for post-treatment sampling.

Between 10 and 14 days after treatment (this timing is critical for a good result) the sheep should be re-mustered and individual faecal samples collected from each group, including the controls. Individual worm egg counts for each sampled sheep and a bulk larval culture for each group should be carried out using the collected samples.

The results (drench efficacies) are obtained by comparing, for each worm species present in the test, the average number of eggs in the treated group sheep with the average number of eggs in the control group sheep.

The Drenchrite™ Drench Resistance Test is a product that allowed assessment of resistance to the BZ, Lev and BZ/Lev combination products by measuring the effects of these products on worm larvae. This test is not used widely any more as it has difficulty in detecting ML resistance but ongoing development is continuing and it might become available again in the future.

Another test using worm larvae is available through NSW Department of Primary Industries to assess closantel efficacy.

It is also possible to get a 'quick and dirty' estimate of drench efficacy if a full drench resistance test is not possible at the time, by checking the worm egg count of a treated group of sheep before and after the drench.

Larval culture results before and after treatment can also add more value to the results obtained this way.

How to construct a drench resistance test

(Source: WormBoss website)
The purpose of a drench resistance test or faecal egg count reduction test (FECRT) is to test the effectiveness of drenches on faecal eggs.

Drench resistance testing should be carried out at least every 2 years, with the help of a veterinarian or animal health advisor to plan the test and worm egg count.

The following describes how to set up a drench resistance test or FECRT. (Source: WormBoss website)

Select appropriate sheep

- They should be young, wormy and un-drenched.
- The sheep should be at least 12 weeks old (if older than 6 months seek professional advice as the test may need to be modified).

Do a preliminary worm egg count

- Collect dung samples (from at least 10 sheep).
- These samples will be tested for enough of the right worm species (i.e. at least 300 eggs per gram is the general rule).

NB. If Barber's pole worm is present it may need to be removed first (using Closantel drench to stop interference with the test for scour worm resistance)

Decide the drenches to test

Seek professional advice on drenches to test. This will depend on the results of any previous test results and the drench history of your property.

See the following drench groups as a guide:

- BZ/LV (white/clear) combination
- Half dose ivermectin (to check for indications of ML resistance—not for normal drenching)
- Full dose Abamectin or Moxidectin (depending on likely treatment choices)
- Rametin mixtures (such as with BZ, LV or BZ/LV)
- No drench (to act as a control group). An untreated control group must be included.

Set up the test groups

Organise test groups of randomly allocated sheep (at least 15 in each group) and one control group (undrenched). The number of groups will depend on how many drenches are being tested.

Identify each group by either ear tagging or spray colour. These groups will be tested again in 10–14 days time.

Drench each group

- After setting up the test groups find the average weight of the two largest sheep in each group to help calculate the dose for each group.
- Now drench each group with the correct drench making sure not to drench the controlled group.
- Special attention must be paid to ensure no cross contamination of drenches occur and that correct drenching technique is used.

Return sheep to the paddock

- After drenching, return the sheep to the paddock mixed together or part of another mob until the next treatment.

Collect faecal samples for worm egg counting

- 10-14 days after initial treatment collect 10 fresh faecal samples from each group including the control group.
- Ask for a larval culture and differentiation on samples from each group by your veterinarian or advisor.

NB Give a 'clean out' drench of a fully effective drench to treated sheep after final samples are collected.

Interpreting results

- With the help of a veterinarian or advisor, compare the average number of worm eggs of the main worm species in each sheep group with that of the control group. These results will test the effectiveness of drench used.
- Fully effective drench = 95% worm egg reduction in relation to undrenched control group

% Efficacy = (control – treatment) / control x 100

For example, if the untreated group average is 500 epg and the treatment group average is 50 epg, then the efficacy of the treatment is:

% Efficacy = (500 –50) / 500 x100

= 90%

Resources

Equipment supplies

Microscopes

Australian Instrument Services Pty Ltd
2/21 Stud Road
Bayswater VIC 3153
Phone: 1800 625 008
Web Address: www.ausinst.com.au

AIS – MIDO FL Objective 4x 10x 40x, Eye piece 10x

Slide Supplier

JA Whitlock
PO Box 51
EASTWOOD NSW 2122
Phone: (02) 9638 1142
Web Address: www.whitlock.com.au

General

Fecpac International
Web Address: www.fecpac.com

Ocean Systems
Web Address: www.oceansys.net

Industry contacts

Queensland

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Trevenna Rd, West Armidale, NSW, 2350
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Para-Tech Veterinary Services
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Kangaroo Island Veterinary Services
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Naracoorte & Penola Veterinary Centres
82 Stewart Tce, PO Box 713, Naracoorte SA 5271
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