NSW GOVERNMENT Department of Primary Industries

primefact

Managing worms in goats in NSW

June 2017, Primefact 1564, first edition
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Introduction

Internal parasites or worms are the most important health problem of goats in Australia, particularly in higher rainfall areas. The cost of worms is due to production losses (which can be significant if not obvious), clinical disease, deaths, and cost of treatments.

The aim of this PrimeFact is help improve the profitability and well-being of goats in NSW through better management of worms. **Also see WormBoss.com.au.**

What worms?

Goats and sheep tend to share the same worms. These include gastrointestinal parasites (round worms, liver fluke, intestinal coccidia, tapeworms), and lungworms. Goats and sheep don't share the same worms with cattle to a great extent, apart from liver fluke.

As with sheep, the most important internal parasites of goats in Australia are:

- *Haemonchus contortus* (barber's pole worm)
- *Trichostrongylus* species (sp) (black scour worm)
- *Teladorsagia* sp (small brown stomach worm)

The three worms (above) are widespread with barber's pole worm especially being a problem in summer rainfall areas with average annual rainfall above 500-600 mm.

- *Fasciola hepatica* (liver fluke). This mainly occurs in higher rainfall areas (>650 mm a year) of south eastern Australia, including tablelands and nearby areas, and some irrigation areas.

Other parasites are either less common or cause significant problems less often. Worms of varying importance are listed in Table 2.

Table 1. Contents

Table 2. Worms of goats

Scientific name	Common name	Location	Effects
Important			
Haemonchus contortus	Barber's pole worm	Abomasum (4th stomach)	Blood including protein loss. Anaemia, bottle jaw[1], exercise intolerance, death.
Teladodorsagia (Ostertagia) circumcincta	Small brown stomach worm	Abomasum	Damage to lining of stomach or intestine, malabsorption, loss of protein, scouring/diarrhoea (occasionally death).
Trichostrongylus species	Black scour worm	Small intestine	
Nematodirus species (especially young goats)	Thin-necked intestinal worm	Small inestine	
Fasciola hepatica	Liver fluke		Liver damage, blood and protein loss, jaundice, bottle jaw, anaemia, deaths, black disease[2].
Less important/less common			
Oesophagostomum venulosum	Large bowel worm	Large intestinal	Not commonly a problem.
Oesophagostomum columbianum	Nodule worm	Large intestine	Once a common and important worm in summer rainfall areas. Nodules in small and large intestines. Deaths when infections are heavy.
Cooperia species	Small intestinal worm	Small intestine	Not commonly a problem.
Lung worms (*Dictyocaulus, Muellerius, Protostrongylus* species)		Lungs	Occasionally a problem especially in individuals which are 'poor do-ers' for other reasons.
Moniezia species	Intestinal tapeworms	Small intestine	Rarely a problem, despite the size and length of these tapeworms.
Taenia and *Echinoccus* species	Larval tapeworms (cestodes)	Larval stages in various tissues. (Adult stages in other animals, e.g. dogs).	Examples of larval tapeworms: hydatids (human health risk); sheep measles (losses through condemnations at abattoirs)

[1]Bottle jaw, also known as submandibular oedema, is a soft swelling beneath the jaw, due to lowered protein levels in the blood.
[2]Black disease is a clostridial disease (due to *Clostridium novyi*), and is preventable by vaccination. It can be associated with liver fluke infections.

Table 2 does not contain a complete list of worms of goats in Australia. Also consider other causes of scouring, such as coccidia, bacteria, viruses, and nutritional mismanagement. All the parasites in Table 2 are roundworms ('nematodes'), except for two flatworms: liver fluke (a 'trematode'), and tapeworms ('cestodes').

More information can be found in NSW DPI Primefacts, including:

- Primefact 811 (lungworms)
- Primefacts 446 and 813 (liver fluke)
- Primefact 810 (nodule worm)
- Primefact 812 (hydatids),
- Primefact 55 (sheep measles)
- Primefact 1341 (managing internal parasites in organic systems) (Archived. Also available at http://wp.me/pRGJe-1NN)

Also see **WormBoss.com.au**, in particular these sections: 'Your Program' and 'Worms'.

Life cycles of worms

Round worms have a simple lifecycle, with one host. The parasitic or adult stage is in the host animal, and the eggs and larvae are on pasture.

Liver fluke has a two host lifecycle, with the adult, sexually reproducing stage in a final or 'definitive' host, which include a number of warm-blooded animals. The larval stages are

in specific types of snails (lymnaeid snails), the intermediate host. In NSW, these snails are mostly found in wet areas on farms in the eastern third of the state, and also some irrigation areas.

Roundworm lifecycle – goats (also sheep, cattle, alpaca)

Adult male and female roundworms in the host animal mate and the females produce eggs. These eggs pass through the gut of the host and out in the faeces. Eggs first appear about 3 weeks (the 'prepatent period') after the host animal ingests infective larvae while eating pasture. It may take a little longer in the case of worms in the large intestine, but can be as soon as 18 days with barber's pole worm. The prepatent period can be as short as 2 weeks (range, 2-3 weeks) with the small intestinal worms, *Cooperia* spp.

Eggs in faeces on pasture develop and hatch after 24 hours or more if there is adequate warmth and moisture. Barber's pole worm eggs are only viable for 5 days, and require more warmth and moisture than 'scour worms' (black scour and small brown stomach worms). Barber's pole worm eggs generally require over 10 degrees C at night, over 18 C during the day, and the equivalent of 10mm or more of rain every 5-10 days.

These characteristics of barber's pole worm make it more susceptible to grazing management. Grazing management involves some paddocks being spelled (not grazed by worm-infected sheep or goats) at various times. Because barber's pole worm eggs are not long-lived, these spelled paddocks will have fewer viable eggs on them when favourable conditions (rain and warm weather) occur.

Eggs of 'scour worms' such as brown stomach worm and black scour worm are viable for longer, up to 3 weeks or more, and are relatively more tolerant of cold and dry conditions. Barber's pole worm is less flexible but partly overcomes this by being a very fecund worm, producing many more eggs (5-10,000 eggs/female/day) than the scour worms (several hundred eggs/day).

First stage larvae (L1) emerge from the eggs and feed on bacteria in faeces. Growing larger, they moult, getting a new cuticle (skin) as they become L2 larvae. They continue to feed, then moult again, becoming L3 larvae, which is the stage infective for host animals. In temperate climates, L3s are produced about 7 days or more after eggs hatch, or 3-4 days in tropical climates. In the case of scour worms, larval development may be delayed under cool conditions, up to several months in winter rainfall regions, with larvae remaining in the pellet until conditions are more favourable. However, barber's pole worm larvae cannot delay development, and the L3s quickly emerge from the faecal pellet.

The optimal temperature for larval development is generally in the range 18-26 degrees C (Taylor and others, 2016).

The L3 larvae are ensheathed (covered with a protective sheath), which makes them more resilient, but they are unable to feed. The longevity on pasture of barber's pole, brown stomach and black scour worm L3 larvae, once emerged from the faecal pellet, is broadly similar.

L3 larvae, having left the dung, move randomly in films of moisture on vegetation, with most larvae being found in the first 100mm above the ground, and some also in the humus. Animals when browsing well above ground level do not ingest many larvae.

The higher the temperature, the faster the larvae deplete energy reserves (lipids), and the sooner they die. At high temperatures, desiccation also comes into play. Larvae survive longest in cool, moist conditions.

Table 3. Survivability of barber's pole worm (*H.contortus*) L3 larvae on pasture

	Daily maxima (degrees Celsius)	Time for 90% to die
Cold	<15	4 months
Warm	~ 22	3 months
Hot	~ 35	1.5 month
Very hot	>40	1-2 weeks

Source and more information: WormBoss.com.au. Appendix 3 in 'Worm Control Program(s)'. http://www.wormboss.com.au/programs.php

Table 3 gives clues as to how long it takes to produce low worm-risk pastures under different conditions. Broadly speaking, most (~ 90%) barber's pole worm L3 larvae die in:

- 3 months (summer) to 6 months (winter) in cool to temperate regions (NSW tablelands);
- 2 months and 5 months in warmer areas (coast and slopes).
- Some survive up to a year or more, depending on the climate, topography and ground and tree cover.

Nematodirus (thin-necked intestinal worm), which is not a fecund parasite, has a different strategy. The larvae can develop to the L3 stage inside the egg and then shelter within the unhatched egg. The egg is very tough and can survive on pasture for around a year or more.

L3 larvae of round worms are ingested by host animals, then ex-sheath to become L4 larvae and then go on to become adults. The adults may live for a number of months within the host animal. Not all ingested larvae establish in the host: more establish in young animals, whereas fewer establish in adult animals in good condition, unless they are on the point of kidding, or are lactating.

Host immunity also reduces the egg output and longevity of worms.

More information:

WormBoss.com.au – Worm Control Program(s); worms-roundworms-roundworm lifecycle.

Life cycle of liver fluke (*Fasciola hepatica*)

After migrating for several weeks as immature fluke through the liver of their hosts, the young fluke enter the bile ducts where they further mature, feed and reproduce. The adults, which are hermaphrodites, can produce even more eggs (20,000-50,000) than barber's pole worm. These eggs, still undeveloped/undifferentiated, pass through the bile ducts and gall bladder, into the intestine, and out in the faeces. The eggs, while still undeveloped, can survive on pasture up to several months, even under freezing conditions.

Eggs deposited on pasture will develop if daily minima are over 10 degrees C, and it is wet. The larvae invade the intermediate hosts (lymnaeid snails) where they go through various stages, developing and multiplying asexually. A tadpole-like larval stage (cercaria) leaves the snail, swims until it finds vegetation, onto which it encysts, forming a tough protective cyst wall. At this point it is the infective stage (metacercaria or 'infective cyst') of liver fluke. The metacercariae can survive winter and into spring, and may be viable for several months or more if conditions are cool and damp. The infectivity of metacercariae however declines once temperatures exceed 20-25 degrees.

Animals grazing in 'flukey' areas on a farm ingest metacercariae. These infective larvae pass through the intestine, making their way over several days to the liver. Once in the liver, the young fluke migrate through the liver for 6 - 7 weeks before entering the bile ducts, growing rapidly as they go, and causing liver damage. Egg production in the bile ducts begins about 8-10 weeks after infection, 10-12 weeks in cattle. Adult fluke can live for several years in small ruminants, less in cattle.

More information in NSW DPI (www.dpi.nsw.gov.au) PrimeFacts:

- Primefact 446 and 813, on liver fluke
- Primefact 476 (Identify liver fluke snails)

Also see the sections on 'Worms' and 'Flukes' at WormBoss.com.au.

Tapeworms

Adult stages of tapeworms

Is it worth treating for intestinal tapeworms (*Moniezia* and other species)?

When you see creamy white rice grain-like segments in the dung, mostly in younger animals, or you see the long adult tapeworms in the small intestine when a post-mortem is done, then quite understandably you will think they must be doing something. However, the great majority of experiments, in sheep at least, have found that tapeworms had no detectable effect on growth or scouring. In the rare experiments that showed some effect, it seems that extraordinarily heavy burdens of tapeworm were present.

If you must treat for tapeworm, remain focussed on the really important but less visible worms, the gastrointestinal nematodes (roundworms), and liver fluke. And, if using a 'tapewormer', usually praziquantel, and usually in combination with a broad-spectrum drench for roundworms, make sure the broad-spectrum part of the product is effective on your property.

Resistance of intestinal tapeworms (*Moniezia*) in sheep to praziquantel has been reported in NZ (Mason and others, 2002). Whether resistance to praziquantel occurs in *Moniezia* in Australia is unclear.

Moniezia tapeworms, like other tapeworms, have an intermediate or larval stage. The intermediate stage of *Moniezia* occurs in a type of pasture mite (oribatid mites).

Larval stages of tapeworms

Larval or juvenile stages of tapeworms are also found (inside cysts) in sheep and goats. These include hydatids and sheep measles. The adult stages of hydatid (*Echinoccocus granulosus*) and 'sheep measles' (*Taenia ovis*) tapeworms live in canids (dogs, foxes).

Humans can be an intermediate host for hydatids, with cysts containing larvae occurring throughout the body, sometimes with grave consequences.

For more information, see these NSW DPI Primefacts:

- Primefact 841. Zoonoses - animal diseases transmissible to humans
- Primefacts 475 and 812. Hydatids
- Primefact 55. Sheep measles

Coccidia

Coccidia are not worms, but are small organisms known as 'protozoans'. The coccida we are most concerned with (*Eimeria* species) inhabit and sometimes damage the intestines of grazing livestock. Normal, healthy animals have coccidia in their intestines. The mere presence of coccidian oocysts ('eggs') in faeces, seen for example when worm egg counts are done, is not enough to justify a diagnosis of coccidiosis. Other things, such as clinical signs have to be considered, as well as other causes of weight loss and 'scouring' (diarrhoea).

Coccidiosis is largely a 'management disease'. It typically occurs in younger animals that are stressed, due to bad weather for example, and held in crowded, wet conditions. The disease can develop quite quickly under these circumstances. Controlling coccidiosis involves managing the predisposing factors and administering appropriate drugs to affected animals. Note that anthelmintics (drenches) have little or no effect on coccidia.

For more information, see the following NSW DPI publications:

- Agfact A7.9.11.Coccidiosis
- PrimeFact 1241. Advice for vets treating coccidiosis
- PrimeFact 841. Zoonoses - animal diseases transmissible to humans

Table 4. Worm control in a nutshell

Control exposure Low-worm risk paddocks for vulnerable animals (Grazing management).
Reduce vulnerability Genetics + nutrition. Buy bucks with a good 'breeding value' for WEC. Meet growth rate and condition score targets.
Measure so you can manage Monitor worm burdens and drench efficacy using worm egg counts (WECs).
Smart treatments The right drench at the right time. Use effective and appropriate drenches at times specified by a good worm control program, with additional drenching based on results from regular WECs. A vaccine (Barbervax®) is an additional option in sheep.

Managing worms

Overview of factors affecting impact of worms on goats

- Level of exposure to infective larvae (pasture 'infectivity')
  - Weather and climate
  - Grazing management: cross grazing, e.g. sheep < > cattle, or spelling paddocks to prepare low worm-risk kidding/weaning paddocks. Zero grazing
  - Egg output from animals: resistance of animals to worms, and drench effectiveness
  - Stocking density and amount of browse consumed
- Vulnerability of animals
  - Age, physiologic status: young animals, lactating, late pregnancy. Stress
  - Nutritional status
  - Genetics
- Management (measure and manage)
  - Regularly monitoring worm burdens: worm egg counts (WECs, WormTests)

- Well-timed treatments: based either on WormTest results, or routine treatments as part of a sound worm control program
- Using effective drenches, which are regularly monitored for effectiveness
- FAMACHA: indirectly measuring effects of barber's pole worm
- Five Point Check System

Control exposure

Low worm-risk paddocks

An important part of good worm control is preparing low worm-risk paddocks for livestock particularly susceptible to worms. In goats this means kidding does and young goats.

But, it's not just about worms. Remember also that kidding and lactating does, and young goats, have high nutrient requirements, so pasture quality and quantity must be good as well as low worm-risk.

Kidding paddocks

Assume you have a Spring kidding, say in September. Preparation time, in order to produce low worm-risk paddocks, will be around 6 months in NSW tablelands areas, and about 5 months in warmer areas.

An adequate preparation period allows time for most of the existing larvae to die off. During this time, avoid adding new contamination (worm eggs in faeces), which will happen if 'wormy' sheep or goats graze the paddock during periods when there is sufficient warmth and moisture for eggs shed in faeces to develop and hatch.

If kidding is in September, and you are in colder areas like the tablelands, then preparation of a low worm-risk kidding paddock begins in March.

Focusing on barber's pole worm, because it is the most problematic roundworm, the worst time to graze sheep or goats on the kidding paddock is in autumn when it is warm enough for new eggs to produce larvae.

So, what are the options? One or more of the following:

- Spelling (including cropping and haymaking)
- Grazing with cattle or horses. Many of the worm eggs or larvae that horses and cattle ingest will die, because these are more adapted to different host species, e.g. sheep or goats.
- Keep in mind that different livestock species prefer different lengths of pasture, and so may not compete for the same part of the pasture.
- Do not over stock, as this increases pasture contamination and also adversely affects pasture quantity and quality.
- Grazing with sheep and goats in cold months, when daily minima are consistently below 10 degrees C for extended periods. In the NSW tablelands, this is usually May-August. Few worm eggs, especially barber's pole worm eggs, will develop and hatch under these conditions.
- 'Smart grazing.' This is short-term grazing with sheep or goats, often at higher than usual stocking rates, in the 3 weeks following a 98-100% effective drench. More information: http://www.wormboss.com.au/tests-tools/management-tools/grazing-management.php

  It is critical the drench has been shown by recent testing on your farm to be highly effective, and that the grazing period is not more than 3 weeks unless, of course, the grazing happens in months when it is too cold for most worm eggs to hatch and produce larvae.

Weaning paddocks

If weaning occurs in summer, say January, then preparation to reduce worm-risk (pasture contamination) does not take as long, as larvae die off faster when it is warm to hot. In the tablelands in summer, the time is about 3 months, down to about 2 months in places like Condobolin or Narrandera.

Remember, it's not just about worms. **Good nutrition** is particularly important for animals such as weaners as well.

Lower exposure though browsing

If browse is available, then goats will spend more time utilising it than most breeds of sheep. An advantage is reduced intake of worm larvae.

It is believed that goats evolved with a greater propensity to browse, and as a consequence developed lower levels of resistance to worms than sheep, which in turn have lower resistance to worms than cattle.

But, remember that vulnerability to worms can be reduced through nutrition and breeding.

Zero grazing

This may be the only practical solution for large milking herds because of the lack of registered drenches for dairy goats and the unknown withholding period for milk of unregistered products, the use of which could be prohibited anyway for use in animals producing milk and related products for human consumption.

More information:

http://www.wormboss.com.au/tests-tools/management-tools/nutritional-management/feedlotting-goats.php

Reduce vulnerability

The main factors here are:

- breeding (good genetics (favourable breeding values))
- good nutrition: "bred well, fed well."

Vulnerability can be thought of in terms of

- host resistance and
- host resilience.

Higher **host resistance** means that fewer ingested worm larvae establish, and fewer worm eggs are deposited on pasture. To improve the overall resistance of a herd of goats to worms, select bucks that have a favourable breeding value for WEC (worm egg count) as well as other traits you are interested in.

A **resilient** animal suffers fewer ill effects associated with worm burdens than other, less resilient, animals. Resilient animals may have high, medium or low resistance. The heritability of resilience is lower than for resistance, but progress in increasing both traits in a herd can be achieved by selecting bucks with good breeding values for resistance to worms, along with good breeding values for growth etc., which will tend to improve resilience.

Nutrition is the other part of the equation. Excellent genetics is worthless if animals cannot express it due to poor nutrition. The first priority in nutrition is to ensure animals are getting adequate amounts of the macronutrients, energy and protein. The next priority is ensuring micronutrients, minerals and vitamins, are adequate. Some areas can be deficient in various minerals, for example, selenium, copper or cobalt. Good get expert local advice on this,

Good nutrition improves resistance and resilience, and thus is an important part of good worm control.

More information: WormBoss.com.au - Worm control program(s); breeding resistant sheep/goats; Test and Tools – breeding for resistance; nutrition for resistance and resilience.

Measure so you can manage

The cost of worms, although substantial, is usually not obvious, unless you do regular objective measurements, for example, growth rates or other measures of productivity.

Most of the cost of worms is due to production losses, far more than the cost of treatments or doing egg counts (WECs).

Recommended measurements:

- WormTests. Do regular WECs to keep track of worm burdens.
- Testing drenches to make sure your treatments are effective.
- Assess animals. Measure productivity (growth rates, condition scores etc.) and visually assess animals for signs of ill-health.

WormTesting

WormTesting (worm egg counts (WECs)) involves collecting fresh dung samples and sending them to a laboratory, or, if you have been trained, doing the egg counts yourself. Fresh samples (produced as you watch) can be collected from the paddock, or from the rectum of animals in a race. Because the eggs of the important roundworms ('strongyle' eggs) look very similar, an extra step, 'worm-typing' or 'larval culture /differentiation', is often done at the lab to determine what worms are present and in what proportions. The choice of drench may depend on the species of worms that are present.

Most labs provide egg count results within 1-2 days of receiving the samples. Larval culture takes an extra 1-2 weeks. (Check with the lab). Take these timeframes into consideration if sampling mobs prior to mustering for particular reasons, in case drenching is required as well.

How often? How many?

As a rule of thumb, in the **eastern half of NSW**, test every

- 4-6 weeks when conditions are good for worms (warm/moist), or
- 6-8 weeks when conditions are relatively unfavourable (cold/dry; very hot/dry).

This is in addition to regular visual assessment of animals.

In the **rangelands of western NSW**, WormTest 6 weeks after rain events producing a green pick. More frequent WormTesting may be needed for animals at higher risk, for example, kids, or animals grazing small areas with green pick.

Work WormTesting in with other management requirements, by scheduling a WormTest (collecting samples from the paddock), two weeks or so before animals are to be mustered and yarded.

Testing each mob is recommended for goats. This is the ideal for sheep as well, but, if there many mobs, test one out of three mobs that are similar, i.e., similar class of animals and similar grazing and drenching histories.

More information: http://www.wormboss.com.au/tests-tools/tests/checking-for-worms-with-a-wormtest.php

What WEC is significant?

Drenching decisions require an assessment of risk (Table 5) as well as comparing WEC results with suggested WEC thresholds (Table 6).

Table 5. Drench or not? Assessing risk in different situations

Higher risk (drench at lower WECs)	Lower risk (drench at higher WECs)
Young animals	Adults
Animals in poor condition	Animals in good condtion
Lactating or late in pregnancy	'Dry' animals
Poor genetics – animals susceptible	Animals less susceptible
Animals stressed: cold, wet, overcrowded	Animals not stressed
Poor nutrition (quantity and /or quality)	Good nutrition
Warm, wet conditions	Very hot/dry or cold/dry
Paddocks are 'wormy'	Paddocks are low 'worm-risk'
Infrequent WormTesting	Regular WormTesting
Minimal browse for goats	Plenty of browse available
Set-stocking (minimal spelling of pastures or rotational grazing)	Good grazing management including rotational grazing

Table 6. Drench or not? Guide to worm egg count (WEC) thresholds (round worms; eggs per gram faeces)

Situation	North-east NSW		NSW - central, southern southwest		Rangelands (western NSW)	
	BPW dominant	BPW not dominant or no culture	BPW dominant	BPW not dominant or no culture	BPW dominant	BPW not dominant or no culture
Lower risk	800-1200	500-700	400	250	800	400
Higher risk	600-800	300-700	250	150	400	300
Summer drench			100	100		

Notes: In higher risk situations, for example, the weather is warm and moist, which favours worms, and/or animals are susceptible, for example, young or lactating, you will need to drench at lower eggs counts. EPG = eggs per gram of faeces. 'BPW dominant' means that, when larval culture and differentiation ('worm-type') has been done as well as an egg count, more than 50-60% of eggs are barber's pole worm (*Haemonchus contortus*). Although not specifically mentioned, scour worms such as black scour and brown stomach worms are accounted for in Table 6.

Next page: Table 7. Alternative/simpler guide – WEC thresholds

Table 7. Alternative/simpler guide – worm egg count (WEC) thresholds (eggs per gram faeces)

Barber's pole worm[1]	'Scour' worms[2]	Summer drenching[3]
>500[4]-1000	>250[4]-500	>100

This assumes worm typing (larval culture / differentiation) has been done as well as egg counts. (These are counts of 'strongyle' ('strongylid', 'trichsostrongyle') eggs, the type of egg produced by the common / most important gastrointestinal roundworms of ruminants). [1]Barber's pole worm (*Haemonchus contortus*). [2]'Scour worms': black scour (*Trichostrongylus* spp) and small brown stomach (*Teladorsagia* spp) worms.
[3]First or second summer drench in the non-seasonal rainfall areasof the eastern two thirds of NSW (= 'DrenchPlan' area = 'NSW central, southern and southwest' in WormBoss.com.au (Goats).[4]The lower end of the WEC range is the threshold for drenching in high risk situations.

More information:

WormBoss drench decision guides

http://www.wormboss.com.au/tests-tools/drench-decision-guide.php

Testing for liver fluke

Tests available:

- Fluke egg count. This is different from the roundworm egg count. Available from most labs.
- Liver fluke antibody ELISA. Available from the NSW DPI State Veterinary Diagnostic Laboratory, Menangle.
- Liver fluke faecal antigen (copro-antigen) ELISA. Available at the NSW DPI lab and the Vet Lab at CSU Wagga Wagga (BIO-X test kit).

When to test?

Good times to test are April-May, August and January- February, or when there are clinical signs (bottle jaw, anaemia, ill thrift) consistent with liver fluke disease.

Treatments

Any positive fluke egg count is significant. If there is no immediate need to drench (health and productivity is good), then a drench at the next time for a strategic fluke treatment is advised.

Most farms with liver fluke will need 1-3 treatments per year depending on the severity of the problem. The times to treat, in order of importance are:

- early winter (April/May)
- early spring (August/September) and
- summer

Use the most effective fluke drenches at the early winter drench.

The most effective fluke drenches are triclabendazole-based drenches. Cattle producers also have the added option of drenches containing the two flukicides, clorsulon and oxyclosanide, i.e., Nitrofluke® or Nitromec®, the latter also containing the broad-spectrum drench, ivermectin. Both these products are injectables, and, like triclabendazole, are effective against all stages of fluke.

Note that some resistance to flukicides has been recorded. To check the efficacy of triclabendazole-based flukicides, a simple method is to do a test on the day of treatment and again 21 days later, using either a fluke egg count or coproantigen test. Check with your advisor for more information on testing flukicide efficacy.

As always, check product labels for directions and restrictions, including withholding periods.

More information:

NSW DPI PrimeFacts 446 and 813 (liver fluke) http://www.dpi.nsw.gov.au/content/agriculture/livestock/health

NSW State Veterinary Diagnostic Laboratory http://www.dpi.nsw.gov.au/content/aboutus/services/das/veterinary

CSU Wagga Veterinary Laboratory https://www.csu.edu.au/vetservices/vdl;

WormBoss: http://www.wormboss.com.au/worms/flukes/liver-fluke.php

Other tests

Haemonchus dipstick

This uses test strips to check for 'occult (i.e. hidden) blood' in faeces, and does this by detecting haemoglobin. Barber's pole worm is the main reason for blood occurring in faeces in small ruminants. Because young worms suck blood before they are sexually mature, this blood appears in the faeces before worm egg counts rise.

Unfortunately the kit, supplied by Merial, is no longer available. Producers who already have the kit can continue to use it by buying the test strips from a pharmacy.

More information:
http://www.wormboss.com.au/tests-tools/tests/assessing-worms.php

FAMACHA

Assessing the colour of eye membranes has long been a way of checking for possible anaemia, but FAMACHA is a method of assessing colour in a standardised way. Named after South African veterinary parasitologist Dr Faffa Malan (FAffa MAlan CHArt), this uses an eye colour chart to assess pallor or otherwise of the eye membranes of sheep and goats, which in turn is an indicator of the degree of anaemia. Barber's pole worm is a common cause of anaemia, but other causes include liver fluke, and the blood parasite, *Mycoplasma (Eperythrozoon) ovis*.

Treatment then is reserved for those animals with sufficiently pale membranes (targeted deworming). Repeat offenders may be culled, although it should be noted that the heritability of resilience is not as high as that for host resistance.

To get the charts, one has to be trained by an accredited trainer.

This is a useful extra tool for managing barber's pole worm, especially if labour costs are not an issue, but don't forget scour worms, and also the fact that resilient animals (pink membranes despite barber's pole worm burdens) may not necessarily be resistant as well. In fact, such animals could be shedding large numbers of worm eggs, increasing pasture contamination.

If FAMACHA is an appropriate tool to use, it may be best to combine it with regular WormTesting.

More information:
http://www.wormboss.com.au/tests-tools/tests/assessing-worms.php

Five Point Check System

The five point check system assists with targeted selective worming rather than 'global' drenching (drenching everything). There are five areas on the goat that assist with recognising a worm issue developing inside the goat.

1. Eye (anaemia)
2. Back (condition scoring)
3. Tail (soiling with faeces)
4. Coat (appearance)
5. Jaw (soft swelling under jaw ('bottlejaw'))

It is important to record this information against the goat's identification number.

Haematophagous ('blood-eating') worms, i.e. barber's pole worm and liver fluke, in particular can cause anaemia and bottle jaw. 'Scour worms' tend to be associated with ill-thrift, scouring and a poor or dull coat.

Drenches and drenching

Right drench

Drenching is still an important part of managing worms. It's important to get it right.

Things to consider:

- Is the drench effective on my farm? *Most important!*
- Narrow-, mid- or -broad-spectrum?
- Short- or long-acting?
- Combinations and mixtures

Narrow-, mid- or broad spectrum

Most worm infections are mixed, even if dominated by one species (often it is barber's pole worm). So, in most cases a broad-spectrum drench will be required, i.e., one that, barring resistance, is effective against most of the important roundworms.

But sometimes narrow-spectrum drenches are appropriate. For example, triclabendazole-based drenches are only effective against liver fluke and, on occasions, you may need to treat for nothing else.

Mid spectrum drench actives include the organophosphate, naphthalophos, which, on its own has high efficacy against some stages of some worms (notably adult barber's pole worm), along with lower but still useful efficacy activity against other scour worms.

Derquantel is also regarded as a mid-spectrum active, although nearer to being a broad-spectrum drench than the organophosphate (OP) drench, naphthalophos. This is because derquantel on its own is not highly effective against all the important roundworms. It has lower efficacy against immature barber's pole worm, and adult and immature brown stomach worm. However, derquantel is only available in combination with the broad-spectrum drench, abamectin (Startect®).

Like most drenches, Startect® is not registered for use in goats.

Organophopshate (OP) drenches also are not registered for use in goats and, with the exception of NAPfix®, are no longer available anyway, although still registered.

OP drenches now off the market include naphthalophos (NAP) or pyraclofos (PYR))-

based drenches registered for sheep (none were registered for goats). Generally these were withdrawn because of problems sourcing key ingredients. These products include Rametin® (NAP), Combat® (NAP), and Colleague® (PYR+albendazole).

NAPfix® (NAP+abamectin+albendazole) was off the market for a time but became available again in autumn 2017.

Note that goats appear to be more susceptible to OP poisoning than sheep.

Short or long?

Everything else being equal, long-acting drenches may select more for resistance in worms than their short-acting counterparts, and should be reserved for situations when they are particularly needed. Such occasions might include vulnerable stock grazing very 'wormy' pastures because lower 'worm-risk' paddocks are not available.

Some definitions (in line with usage on WormBoss.com.au):

- Short-acting drenches are those with no claim for persistent protection,
- mid-length claim 7–28 days protection, and
- long-acting, 91–100 days.

More information:
http://www.wormboss.com.au/tests-tools/drench-decision-guide.php

Effective!

Two of the most common 'worm control' mistakes are:

- Guessing whether you need to drench or not
- Unwittingly using a drench rendered ineffective by resistance of worms.

Both mistakes can hasten the onset of drench resistance, and badly affect your bottom line.

These mistakes in most cases can be avoided by doing regular WECs.

Whether new or old, the effectiveness of all drenches should be regularly monitored. DrenchCheckDay14 is an easy and highly cost-effective way of checking the effectiveness of drenches against roundworms. This entails a WormTest on or just before a mob is drenched and again 14 days later.

More information:
http://www.wormboss.com.au/tests-tools/tests/checking-for-drench-resistance.php

A third common mistake is undue reliance on drenches.

Combinations and mixtures

In this PrimeFact, we use the same terms used in WormBoss/ParaBoss and many other sources of information. Some publications, especially older publications, refer to 'combinations' (as used above), as mixtures.

Combinations contain two or more active ingredients, usually unrelated actives, each of which target the same worms. An example: abamectin + levamisole + oxfendazole. These three have the same spectra of activity, but come from different drench families or groups, and so have different modes of action.

Consider using combinations if possible, even if the active ingredients they contain are still effective on their own on your farm. Combinations generally will kill more worms, including resistant worms, than their constituents when used singly. It is believed that using combinations as a part of an integrated worm management program will slow the development of worm resistance to drenches.

When it comes to delaying the onset of resistance of nematodes to drenches, rotation or alternation of unrelated single actives has a limited effect compared to combinations. This was shown in computer modelling up to 30 years ago (Barnes and others, 1995; Smith G, 1990) and more recently (Kahn, 2016).

Apart from that, and because of the prevalence of resistance, some farmers have no choice but to use combinations in order to achieve satisfactory drench efficacy.

Mixtures contain two or more actives, but with different spectra of activity. An example: triclabendazole + ivermectin. The former is active against liver fluke, the latter against round worms.

Since we have mentioned 'mectins', note that ivermectin and abamectin are both short-acting and both are avermectins, a subgroup within the macrocyclic lactone (or 'mectin') group. There are advantages in using abamectin rather than ivermectin due to its greater potency in small ruminants, which means it will kill more worms including resistant worms.

More information:
http://www.wormboss.com.au/tests-tools/management-tools/drench-mixtures-and-combinations.php;
http://www.wormboss.com.au/tests-

tools/management-tools/combination-drenchesbenefits-and-efficacy.php

To predict likely efficacies of combinations using drench resistance tests results for single actives, go to the calculator on WormBoss:

http://www.wormboss.com.au/tests-tools/management-tools/combination-drench-efficacy-calculator.php.

Combinations are not a 'magic bullet': they should be used as part of an integrated approach to worm control.

Right time

There are basically two 'right' times to drench:

- Routine treatments specified in the WormBoss program for your area
- When WormTesting indicates you need to drench.

The routine drenches are what experience combined with testing have shown to be needed in a region in most years.

Table 8. Summary – regular / routine drenches (NSW)

<table>
<tr><th colspan="2">Regular/routine drenches</th><th>Extra drenches</th></tr>
<tr><th>Roundworms</th><th>Liver fluke</th><th></th></tr>
<tr><td>Eastern half of NSW</td><td rowspan="5">On 'fluke'-infested farms, 1-3 drenches per year as required. Time: early winter (most important); early Spring; Summer. Also as part of a quarantine drench, if necessary. (Note: liver fluke can also be found in irrigation areas,not just on tablelands and nearby areas).</td><td rowspan="5">All extra drenches (for roundworms or liver fluke) are based on WormTesting results. Regular Wormtesting is required in eastern half of NSW, and depending on need in Rangelands of western NSW, e.g. 6 weeks after rainfall events that produce green pick, etc.</td></tr>
<tr><td>Does, pre-kidding</td></tr>
<tr><td>Kids, at weaning</td></tr>
<tr><td>Summer drenches in central, southern and southwestern NSW (the old 'DrenchPlan' area)</td></tr>
<tr><td>Rangelands of western NSW</td></tr>
<tr><td>No rountine drenching,apart from 'quarantine' drench of imported animals. Drenching is based on WormTesting.</td><td colspan="2">See main text for more detail.</td></tr>
</table>

Timing of the most common routine drenches

- Weaners at **weaning**.
- Pre-kidding drench. This is recommended in most areas, apart from low rainfall areas where goats range widely.
- **Summer drenches**. In the non-seasonal rainfall areas of central, southern and south-western NSW, also known as the DrenchPlan area, one or two summer drenches are also recommended, but not if egg counts are very low (below 100 epg). The first summer drench, usually timed for when pastures are haying off (often around October/November), may coincide with the weaning drench.
- **Fluke drenches**. 1-3 drenches per year, depending on how severe the problem is.

Extra drenches

Be guided by regular WormTesting to see if extra drenches are required. WormTest every 4-6 weeks when conditions are favourable for worms; 6-8 weeks when conditions are not so favourable). For more information on drenches, see Table 5 (page 14) and Figure 1 (page 16).

Drenching in the Rangelands

In lower rainfall western NSW (the rangelands or pastoral zone), routine drenching is unnecessary in most years, and is instead based entirely on WormTesting, for example:

- 6 weeks after rain events that produce a green pick, or
- 6 weeks after sheep or goats have been congregating on small areas, or
- 2-3 months after sheep or goats have been grazing areas with green pick, for example near bore drains or irrigation channels, or
- before mustering, or
- before animals are weaned, or reach 4-6 months of age, or
- WormTesting because animals look as if they could be 'wormy' (with signs such as scours, ill-thrift, anaemia).

Calendar-based drenching?

Drenching based entirely on the calendar, say every 3 months or some other interval, as opposed to what is recommended in this PrimeFact or in WormBoss, is not recommended.

It has a number of drawbacks, including:

- Unnecessary or poorly timed drenching, the costs of which may include increased

drench and labour costs and increased selection for drench resistance.

- Under-drenching in some seasons, with substantial losses in productivity and increased risk of ill-health and deaths.

Drenching by the calendar does not account for all the variables that affect worm populations: variations in seasons, weather, location, host animals, nutrition, genetics etc.

If part of the reason for calendar-based drenching is to save on WormTesting, then monitoring of drench efficacy, using DrenchCheckDay14, may also be neglected for the same reason. This means there is a high risk that ineffective drenches will be used, increasing the chances of control failures. Money saved on WormTesting will not offset losses due to poor worm control.

Drenching – other considerations

Follow the label, use the right dose rate

Use the right dose rate. For appropriate dose rates for goats, consult your veterinarian.

Dose accurately

Check drench guns for accuracy.

Drench to the heaviest in the mob unless bodyweights vary considerably in which case you may have to draft off lighter goats for treatment at a lower does rate, as specified by the product label or the prescribing veterinarian.

Reduce feed before drenching (for some drench types)

For white (BZ), macrocyclic lactone (ML) and closantel drenches, but not clear (LEV) or organophosphate (OP) drenches, reducing feed but not water 12-24 hours before and several hours after treatment may make the drench more effective. Withholding food will lead to a decreased transit time of the digesta in the stomachs and therefore will increase the drug contact time with parasites. Do not restrict feed or water in heavily pregnant, stressed or poor sheep. Do not restrict feed or water before or after using OP or LEV drenches (Hennessy and Ali).

Increased contact time with parasites, particularly important for BZ drenches, can also be achieved by repeat dosing, in the case of BZs, after 12 hours (Merck). Get advice from your veterinarian and check the label. There may be stipulations regarding re-treatment intervals.

Far **more important** than withholding feed, or repeat dosing, is regular testing of drenches on your property and using those that are found to be >95% effective or, better, >98% effective.

Place the tip of the drench gun over the animal's tongue

With the head of the animal held horizontal, introduce the drench gun from the left hand side (if you are right-handed) to the rear of the mouth, so the tip of the gun goes over the animal's tongue.

If you insert the gun and deposit drench at the front of the mouth, this will stimulate the sucking reflex and closure of the oesophageal groove in some animals, resulting in drench being directed to the fourth stomach, thus bypassing the rumen. Drench that goes into the fourth stomach (abomasum) may be less effective, due to more rapid absorption (Hennessy and Ali).

Take care not to direct drench into the windpipe and lungs. Do not pull the head higher than the horizontal because the higher the head goes the greater the chance that drench will go into the windpipe, possibly causing pneumonia and even death.

Drenches registered for use in goats

There are few drenches registered for use in goats. (See Table 5).

Sheep drenches can only be used in other species if you have written directions from your veterinarian. Note that dose rates recommended for sheep are usually inappropriate for goats. Seek veterinary advice. Considerations include safety, efficacy and withholding periods.

Remember too that the inappropriate use of pour-on cattle drenches in other species can result in poor efficacy and increased selection for drench resistance.

In South Australia, cattle drenches can be used in goats at the dose rates on the label. Get advice from your veterinarian. In Victoria, sheep drenches can be used in goats, however, a veterinary prescription is still required if the dose rate varies from that specified on the label.

Establish a relationship with your vet

Given restrictions on off-label use of drenches, as well constraints on how various drugs can be used, and the requirement for veterinarians to prescribe only for bona fide clients, it makes sense to have a working relationship with the

veterinarian of your choice, quite apart from expert advice and other services they can offer. Of course this does not preclude working with other expert advisers as well, who can also provide good advice.

Table 5. Drenches, including drenches registered for goats (Adapted from NSW PrimeFact 152, "Anthelmintics…")

Drench groups and actives	**Worms**	**Short brand names (examples)** (Registered for goats unless indicated otherwise)
Group 1-BZ (benzimidazoles/ pro-benzimidazoles)('white') [B] albendazole fenbendazole oxfendazole	Barber's pole worm, 'scour worms', adult liver fluke (at higher dose rate), nodule worm, aids control of intestinal tapeworm (*Moniezia*).	Alben, Beezed, WSD Albendazole, Valbazen (albendazole), Fenbender 25, Beezed LV, 4Farmers Fenbendazole, WSD Fenbendazole, Panacur 25 (fenbendazole; registered for dairy goats), Oxazole LV, Oxfen LV, Virbac Oxfen (oxfendazole).
Group 2-LV (levamisole) ('clear') [B] levamisole morantel	Barber's pole worm, 'scour worms', nodule worm.	Oralject (morantel) There is no levamisole drench (Nilverm etc.) registered for goats.
Group 3-ML (macrocyclic lactones) [B] (sometimes called **'mectins'**) ivermectin abamectin moxidectin	Barber's pole worm, 'scour worms', nodule worm.	Caprimec (abamectin) (Registered for goats, including dairy goats). No other ML registered for goats.
Group 4-AD (amino-acetonitrile derivatives) Monepantel (Zolvix®)	Barber's pole worm, 'scour worms'.	Not registered for goats.
Group 5-SI (spiroindoles) Derquantel (Derquantel+abamectin=Startect®)	Barber's pole worm, 'scour worms', nodule worm.	Not registered for goats.
OP (organophosphate) [M] naphthalophos (NAP) (OPs have lower or variable efficacy against 'scour worms' in the upper GIT and immature barber's pole worm).	Barber's pole worm, 'scour worms'.	None registered for goats. Previously trichlorfon (Neguvon) was available for use (against *Haemonchus*) under permit. Safety margin of NAP is lower in goats than in sheep.
T(CB)Z (a modified benzimidazole) (flukicide) [N] triclabendazole	Liver fluke (all stages); not effective against roundworms.	Exifluke, Fasinex, Flukare,WSD LV Triclabendazole, Young's Tricla.
SA (salicylanilides/phenols) [N] closantel nitroxynil oxyclozanide	Liver fluke (> ~ 9 weeks and adult) and barber's pole worm.	Registered for sheep, but **not goats**: Closicare, Sustain (closantel) Trodax (nitroxynil) Nilzan[B] (levamisole[B] + oxyclozanide[N]).
IQ (isoquinolone) [N] praziquantel	Intestinal tapeworm (*Moniezia*).	Registered for sheep, but **not goats**: Praziquantel[N] is only available in combination with broad-spectrum drenches. First Drench[B], Genesis Tape[B]
Combinations and mixtures. There are also products that include a number of actives from different drench groups. (Few if any are registered for use in goats). For example, 'triple-combinations', containing actives from groups 1, 2 and 3, are commonly used in sheep. There is also a 4-way combination, effectively a 'triple' with closantel added as the 4th active. Examples of mixtures include triclabendazole + ivermectin, and oxyclozanide + levamisole. (See page 12 for more information on combinations and mixtures).		

Notes on Table 5

Not all the notes below relate to drenches that are registered for goats, but may apply to drenches that could be used off-label, by veterinary prescription.

Source: Adapted from table in WormBoss / ParaBoss and other sources * NSW DPI does not endorse specific brands. The products listed are examples only. For a complete and up-to-date list, consult the Australian Pesticides and Veterinary Medicines Authority searchable database: https://portal.apvma.gov.au/

Also see: Anthelmintics (drenches) for sheep, goats and alpacas, NSW DPI Primefact 152, Second edition, June 2016, and WormBoss: www.wormboss.com.au/drenches.php (This also contains **a price guide**).

Group 1-BZ. Some benzimidazoles, depending on the dose rate, are contraindicated in early pregnancy (Merck, 2017). Check label information.

Group 2-LV (levamisole) ('clear') is also called the imidazothiazole (e.g. levamisole) / tetrahydropyriminde (e.g. morantel) group. Mammalian toxicity with levamisole is seen more often than with benzimidazoles, although toxic signs are unusual unless the normal therapeutic dose is exceeded (Merck, 2017).

Group 3-ML is also called the avermectins/milbemycins group, with moxidectin being an example of a milbemycin. (See Taylor and others, 2016; Merck, 2017).

Breadth of activity across different worm species: B=Broad-spectrum; M=Mid-spectrum; N=Narrow-spectrum.

Length of protection: Varies from short-acting ('knock-down' that kills susceptible worms within the animal) to mid-length (approx.1–6 weeks activity against incoming larvae) and long-acting (approx. 3 months).

The mid-length and long-acting drenches not only kill susceptible worms already in the animals, but also susceptible infective larvae that the sheep ingest during the protection period.

Actives: An 'active' is the chemical in a drench responsible for killing worms. Some drenches have more than one active and are called 'multi-active' or 'combination' drenches.

Combination or multi-active treatments: Proprietary treatments containing more than one active, and formulated to be compatible as a mixture. Do not mix your own drenches unless the product label or manufacturer state that you can. 'Combination' is often used to refer to a drench with two or more unrelated broad-spectrum actives, with 'mixture' referring to a drench containing a narrow spectrum active as well as a broad-spectrum active. More information here: http://www.wormboss.com.au/news/articles/drenches/understanding-drenches-mixtures-combinations-and-both.php

Product formulation: All single actives are available as oral drenches. Moxidectin is also available as injectable products. Intra-ruminal/controlled release capsules are available with BZ and/or ML actives. Abamectin is also in a pour-on formulation for both lice and worm control.

'Scour worms': Mainly black scour and (small) brown stomach worms, but also others, including thin-necked intestinal worm (*Nematodirus*).

Label: Check product labels for full details. Follow the label.

Other drenches: Clorsulon (sulphonamide group) is a flukicide and is found in various cattle drenches. Nitroxynil is the active in Trodax®, which is not currently available. However nitroxynil is an active in the cattle drenches Nitromec® and Nitrofluke®. Because rumen bacteria metabolize and destroy the activity of nitroxynil, it must be injected (Merck).

Other parasites: See 'Drenches' in WormBoss.com.au for detail on the effectiveness of drench groups against parasites not listed above.

GIT: Gastro-intestinal tract.

Drenches for dairy goats: Caprimec® (abamectin) and Panacur 25 (fenbendazole) are the only products with a milk withdrawal time registered and can be used in dairy goats. The labels on other products say something like this: "Do not use in female sheep or goats which are producing or may in the future produce milk for human consumption".

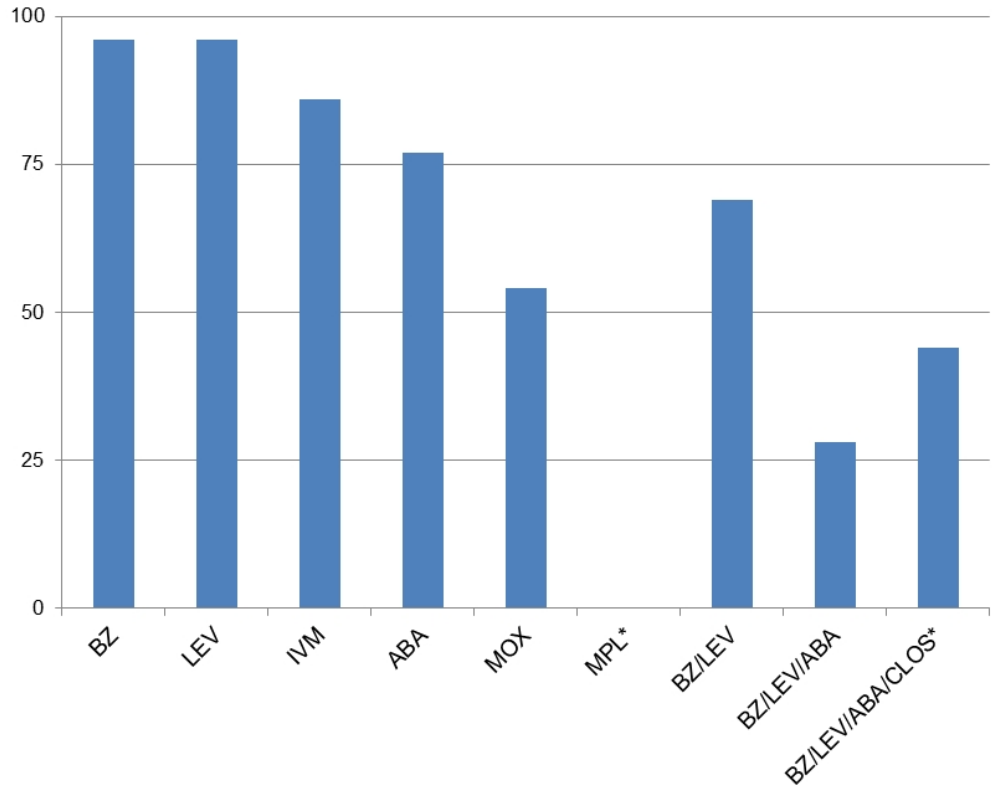
Drench resistance – how common?

Resistance to drenches used in Australia for grazing livestock – goats, sheep, cattle, alpacas, horses - is common. The figure below summarises some of the results from Playford and others (2014), who analysed laboratory

data on drench resistance tests in sheep throughout Australia for the period 2009-2012.

The data indicate that resistance is very common, but does not specifically say which drench will work on your property. Resistance varies between farms, even neighbouring farms. Each property needs to do its own testing to determine what drenches are effective.

Figure 1. Proportion of drench resistance tests (in sheep) showing resistance: Australia, 2009 - 2012 (Playford and others, 2014)



Notes

Figure and notes sourced from NSW DPI PrimeFact 152, “Anthelmintics (drenches) for sheep, goats and alpacas”.

The results are for ‘all worm species’ (i.e., ‘undifferentiated strongyle egg counts’), which includes common sheep worms such as barber’s pole, brown stomach and black scour worms. BZ = benzimidazole. LEV = levamisole. IVM = ivermectin. ABA = abamectin. MPL = monepantel. MOX = moxidectin. BZ/LEV = a BZ/LEV combination. BZ/LEV/ABA = an ML-based ‘triple’ combination containing ABA, BZ, LEV. BZ/LEV/ABA/CLOS = a 4-way combination which also contains closantel. An asterisk (*) against a drench indicates there were less than 50 tests for that drench, so results should be interpreted with caution. For example, the results do *not* say that 44% of sheep farms across Australia have resistance to the BZ/LEV/ABA/CLOS. Further, many of the tests for this 4-way combination came from the New England region. The results are based on samples submitted to laboratories across Australia, so this is not a survey of randomly selected sheep farms. Thus the figures are not to be taken as accurate estimates of the prevalence of resistance: the results are merely indicative. Since this analysis was done, a small number of cases of resistance to MPL on sheep and goat farms have come to light. Additionally there have been occasional cases of reduced efficacy of Startect® (=derquantel + abamectin), to around 90%, instead of being >95%, as usual. This reduction in efficacy is believed to occur in situations where there is severe resistance to the abamectin component of the drench. As yet (June 2017), resistance to derquantel has not been reported.

So, what drench do I use?!

Consider this scenario: you have goats sick or dying and worms have been confirmed as the cause. You need to treat them with an effective drench. What do you use? If you have involved a skilled adviser (especially if that adviser is a vet, and has certain prescribing rights), but unfortunately the resistance profile of your property is not yet known. Some educated guesswork, augmented with good local knowledge, may help to choose 'best bet' options. In many cases, given the current resistance situation in Australia, this will involve the concurrent use of a number of unrelated drench actives.

There are members of three different broad-spectrum drenches registered for use in goats in Australia (See Table 5). These are drenches from:

- the BZ group (some products);
- morantel (Oralject®), from the levamisole group; and
- abamectin (Caprimec®), from the macrocyclic lactone group.

However, product availability and, in the face of resistance, poor efficacy, may be issues. For this and other reasons, a veterinarian may consider other options as well, which could involve off-label use of a drench.

Once the crisis has passed, the smart thing is to work out by testing, with the aid of the appropriate adviser, what your drench options are.

Furthermore, you may avoid future crises by having a good worm control plan, which includes using drenches known to be effective (by testing), and regular monitoring of worm egg counts so you know when to drench.

What Route?

Oral drenches are generally recommended. The efficacy of pour-ons in goats, which carry less subcutaneous fat than cattle, is not well established. The absorption of pour-on drenches in goats and hence their bioavailability and efficacy may be reduced and the regular use of pour-on drenches may promote the development of resistance and should be avoided.

Increasing the useful life of drenches

Strategies to delay the onset of resistance:

- Don't drench unnecessarily
- Only drench if your worm control program (also see WormBoss.com.au) specifies a routine or regular drench. Otherwise use regular WormTesting to help decide whether to drench or not.

Especially avoid unnecessary drenching of relatively immune animals (adults in good condition that are not lactating or in late pregnancy), or when there are few worms 'in refugia': during droughts, or when moving animals to very clean paddocks, e.g., cereal stubbles.

Use effective drenches

Use drenches that are >95% or, better, >98%, effective.

The resistance profile of every farm is different. A DrenchTest (worm egg count reduction test) is recommended every 2-3 years. In between DrenchTests, monitor efficacy of drenches by doing regular DrenchChecks on both new and older drenches. Never assume any drench will work unless you have tested it recently.

More information:
http://www.wormboss.com.au/tests-tools.php

Combinations or drench rotation

Having found by testing what drenches are effective on your property, rotate between unrelated drenches or, much better, use combinations of unrelated actives. Currently the evidence suggests that rotating or alternating between unrelated single-active drenches has limited benefit in delaying resistance and, when there is a benefit, it mainly occurs if rotational grazing is practiced as well.

More information:
http://www.wormboss.com.au/tests-tools/management-tools/combination-drenchesbenefits-and-efficacy.php

Short rather than long

Aim to use short-acting rather than long-acting drenches where possible. If using a long-acting drench, get advice on the use of 'primer' and 'exit' drenches. These are effective short-acting drenches unrelated to the active in the long-acting product, and used at the beginning ('primer') or towards the end ('exit') of the protection period of the long-acting product.

More information:
http://www.wormboss.com.au/tests-tools/management-tools/effective-use-of-longacting-drenches.php

Give the right dose – safety and efficacy

Follow the label or veterinary advice (off-label prescription) on correct dose rates.

Weigh animals and drench to the heaviest, unless bodyweights are variable, in which case draft into subgroups of reasonably even bodyweights. If drenching small numbers of animals, the dose given can be individualised.

Calibrate drench guns using a measuring cylinder, preferably one of sufficient volume to contain a few doses delivered using a natural hand action. Even new drench guns may need calibration.

Goats are particularly at risk of being over-dosed, resulting in toxicity.

Some reasons for this:

- Visual assessment of bodyweight is not always accurate.
- There can be big variations in bodyweights within a mob of goats.
- Higher dose rates than used in sheep are often required and recommended, which can mean reduced safety margins.
- Goats are more susceptible to toxicity from some chemicals than sheep. An example is organophosphate drenches.

Due care is needed when administering any drug to an animal, but some of the drenches most often associated with toxicity in goats include naphthalophos, levamisole (tremors, frothing at the mouth etc., in these first two), closantel (blindness) and abamectin (flaccid paralysis, especially in very young goats). Aspiration pneumonia can happen with any drench if incorrect technique (head held too high) is used, and the goat gets a 'lung shot'. Also, a hypersensitivity reaction has been seen in goats with large burdens of lungworm and which have been treated with injectable levamisole (K Greentree, personal communication). (Levamisole is not registered for use in goats).

Having said this, if drenching is done well, there are relatively few 'adverse events' with modern drenches.

More information:

Merck (Veterinary Manual), 2017 - Safety of Anthelmintics. (See references).

Maintain worms 'in refugia'

We have mentioned this, but worms 'in refugia' are those that, at the time of drenching, are not exposed to a drench and selected for resistance. Generally this means the free-living stages of the worm population, i.e. the worms and larvae on pasture at the time of drenching. The worms in animals that are not drenched, deliberately or otherwise, are also part of 'refugia'.

Some producers leave a percentage of animals undrenched, but this can be risky in some situations, for example, where barber's pole worm is a problem. Get good advice before doing this.

If goats are drenched and then moved to a clean paddock - particularly a very clean paddock - then there will be few worms in refugia on the clean paddock. There were very few worms on the paddock, and worms added to the paddock after drenching will be the progeny of resistant worms surviving the drench. There are few relatively susceptible worms to 'dilute' the relatively resistant ones that are added to the paddock.

So, if 'drenching and moving', firstly make sure drenching is necessary. If it is, drench and move to a wormy paddock initially, if possible, or just delay moving to a clean paddock after drenching for a week or two.

More information:
http://www.wormboss.com.au/tests-tools/management-tools/managing-drench-resistance.php
http://www.wormboss.com.au/tests-tools/management-tools/using-refugia-to-prolong-drench-life.php

Don't import resistance

Unless you never use drenches at all, the worm population on your farm will gradually develop resistance to anthelmintics. However, this can be delayed using the strategies outlined above.

The other way to get resistance is to import resistant worms from other properties by way of goats (or sheep or alpacas) brought on to your farm from elsewhere. To reduce the risk of this, **a good 'quarantine' procedure** is required.

Assume all new goats are a source of anthelmintic resistant worms. Accordingly, they should be drenched with an effective combination of unrelated drenches before release onto the farm.

To optimise the chances of killing currently known resistant worms, one of the drenches should be one of the newer drenches, Zolvix® (monepantel) or Startect® (derquantel + abamectin). (Being an 'off-label' use in goats, both these products require a veterinary prescription).

Use one of these newer drenches concurrently with 2-3 unrelated broad-spectrum actives.

Hold new animals on a 'quarantine' paddock for 3-4 days, to allow passage of worm eggs through the gut, before releasing onto the property. This quarantine period may be somewhat longer than 3-4 days due to biosecurity needs relating to other disease agents, for example, footrot, lice, or Johne's disease.

To make doubly sure the quarantine drench worked, do a 'DrenchCheckDay14', i.e. a worm egg count on the day of drenching and again 14 days later.

For more detail, see here:

Quarantine drenching - don't import resistant sheep worms. NSW DPI PrimeFact 477, Second edition, Aug 2016. Accessed October 2016 at http://www.dpi.nsw.gov.au/content/agriculture/livestock/sheep/health/quarantine-drench-sheep-worms, or

http://www.wormboss.com.au/tests-tools/management-tools/quarantine-drenches.php

Other treatments for worms

Barbervax® vaccine for barber's pole worm (sheep)

There is now a vaccine registered in Australia for use in sheep to control barber's pole worm.

Barbervax will not be registered for use in goats in Australia in the foreseeable future.

After numerous enquiries from owners, three field trials funded by Meat and Livestock Australia were conducted with a view to registering Barbervax for goats. Unfortunately the results were mixed and for unknown reasons the vaccine did not work on one of the properties. It was not considered economically viable to run the numerous trials needed to determine whether the failed trial was an unusual result.

Nematophagous fungi

Work on naturally occurring worm-eating (nematophagus) fungi (*Duddingtonia flagrans*) has been done in Australia and overseas.

These fungi trap and destroy worm larvae inside sheep faecal pellets. CSIRO and a commercial partner have researched a product using this technology, but it is not yet available.

Copper

It has long been known that copper at the right dose is toxic to barber's pole worm, hence the traditional use of 'bluestone' (copper sulphate), sometimes as 'bluestone, nicotine and arsenic', before the advent of modern drenches.

However, the margin of safety was small, and often there were sheep deaths from copper poisoning, with an increased risk of toxicity in areas with plants containing pyrrolizidine alkaloids such as: Heliotrope (*Heliotropium* sp), Paterson's Curse (*Echium* sp) and Fireweed (*Senecio* spp). These plants cause liver damage and increased susceptibility to copper poisoning.

Copper oxide wire particles (COWPs), packed into capsules, have been shown to be toxic to barber's pole worm as well. Note that copper oxide wire particles are only effective against abomasal worms, leaving the small intestinal and large intestinal worms unaffected. Also note that, in Australia, COWPs are intended to correct copper deficiency, and are only registered for that purpose. They are not registered for use against worms, and may cause toxicity in areas with the plants listed above.

Botanical dewormers

The effects against gastrointestinal worms of botanical wormers such as garlic and wild ginger are still to be evaluated. Without appropriate evidence, their use cannot be recommended. If they are used, it is doubly important to monitor the health and productivity of animals, which includes regular worm egg counting.

Forages

Forages, chicory for example, that contain condensed tannins may reduce faecal egg counts, decrease the hatch rate of eggs and impair larval development.

Diatomaceous earth

As noted by Whitley and Miller (2015), diatomaceous earth (DE) does contain trace minerals. Although not proven experimentally, it's possible that DE could sometimes be beneficial to animals with mineral deficiencies. This may explain why some goat owners report a visual improvement in the health of animals given a DE supplement but again, solid evidence is lacking.

Although diatomaceous earth has been shown to have insecticidal properties, there is currently no good evidence for use of this product for gastrointestinal nematode control. Most well designed studies published in the scientific literature have found no significant impact of DE products on gastrointestinal nematode infections in sheep, goats or cattle. According to Matthews (2009), if DE has any effect, it may be causing the pellet to dry out faster, reducing the number of eggs that produce third stage (L3) larvae.

Alternative treatments – more information

See this NSW DPI PrimeFact:

Managing internal parasites in organic livestock production systems. May 2014 Primefact 1341 by Robyn Neeson and Stephen Love. (Accessed June 2017 at http://archive.dpi.nsw.gov.au/__data/assets/pdf_file/0007/518191/managing-internal-parasites-in-organic-livestock-production-systems.pdf)

Goats in the rangelands

Free-ranging goats in the lower rainfall Rangelands of western NSW are harvested and often confined on smaller areas prior to shipping, or kept indefinitely for the purposes of developing a farmed goat enterprise, which might involve crossing with goats such as Boers.

Once confined rather than allowed to roam and browse freely, the risk of production loss or disease from worms increases, especially if kept on small areas, or during times of unseasonably wet conditions. The highest risk situations are when there is flooding and goats are trapped on small wet areas. In these cases the risk of heavy worm burdens and also of coccidiosis, not to mention other conditions, is high.

In higher risk situations, regular WormTesting should be done, perhaps as often as every 4 weeks when conditions are warm and moist - very favourable for worms - and effective stocking rates are high.

Another risk is when goats – for example Boer or other bucks – are brought into the rangelands from higher rainfall areas elsewhere in Australia. One of the biosecurity issues to deal with is that of drench-resistant worms. See section above on 'quarantine'.

References and more information

Barnes EH, Dobson RJ and Barger IA, 1995.Worm control and anthelmintic resistance: adventures with a model. Parasitology Today, 1995.

Hennessy DR and Ali D. "Successful worm treatment". CSIRO pamphlet. (Out of print, but see Knox and Hunt, 2014).

Kahn LP, 2016, citing modelling by Dr Yan Laurenson. Drench rotation does little to combat drench resistance. Accessed October 2016 at http://www.wormboss.com.au/news/articles/drench-resistance/drench-rotation-does-little-to-combat-drench-resistance.php

Knox M and Hunt P, 2014. Evaluation of anthelmintic efficacy and dosing practices in goats. Project code: B.GOA.0088 Report prepared by: Malcolm Knox and Peter Hunt CSIRO, Agricultural flagship Date published: July 2014. ISBN: 9781740362276. Published Meat & Livestock Australia Limited Locked Bag 991 NORTH SYDNEY NSW 2059. Accessed September 2016 at http://www.mla.com.au/research-and-development/search-rd-reports/final-report-details/Animal-Health-and-Biosecurity/Evaluation-of-anthelmintic-efficacy-and-dosing-practices-in-goats/298.

This report by Knox and Hunt is summarised in the WormMail newsletter: https://wormmailinthecloud.wordpress.com/2016/07/19/wrml-2016-07-19-drenches-goats-primefact-drenches-resilience-primelambs-poultry-besier-etc/ (Accessed September 2016).

Love S and Hutchinson GW, 2003. Pathology and diagnosis of internal parasites in ruminants. In Gross Pathology of Ruminants, Proceedings 350, Post Graduate Foundation in Veterinary Science, University of Sydney, Sydney; Chapter 16:309-338. Accessed May

2017 at https://wormmailinthecloud.wordpress.com/2017/04/20/wrml-2017-04-20-love-and-hutchinson-2003-pathology-and-diagnosis-of-internal-parasites-of-ruminants/

Love S, 2016. Anthelmintics (drenches) for sheep, goats and alpacas. NSW DPI PrimeFact 152. Accessed September 2016 at http://www.dpi.nsw.gov.au/content/agriculture/livestock/sheep/health/registered-drenches-sheep-worms

Mason P, Moffat J and Cole D. 2002. Tapeworm in sheep revisited. Proceedings of the 32nd Seminar of The Society of Sheep & Beef Cattle Veterinarians NZVA, Wellington, 22-24 May 2002. Pp. 147-51.Accessed October 2016 at https://wormmailinthecloud.wordpress.com/2016/10/05/wrml-2016-10-05-tapeworms-revisited-incl-reduced-efficacy-of-praziquantel-mason-nz-overview-nsw-dpi-agric/

Matthews JG, 2009. Diseases of the Goat, 3rd edition. Chelmsford, UK. (4th edition published by Wiley in September, 2016. ISBN: 978-1-119-07351-2). http://au.wiley.com/WileyCDA/WileyTitle/productCd-1119073510.html

Merck (Veterinary Manual). Accessed May 2017 at http://www.merckvetmanual.com/mvm/index.html .

Merck (Veterinary Manual), 2017 - Safety of Anthelmintics. Accessed May 2017 at http://www.merckvetmanual.com/pharmacology/anthelmintics/safety-of-anthelmintics

Neeson R and Love S, 2014. Managing internal parasites in organic livestock production systems. NSW DPI Primefact 1341. Accessed June 2017 at http://archive.dpi.nsw.gov.au/__data/assets/pdf_file/0007/518191/managing-internal-parasites-in-organic-livestock-production-systems.pdf).

Playford MC, Smith AN, Love S, Besier RB, Kluver P and Bailey JN, 2014. Prevalence and severity of anthelmintic resistance in ovine gastrointestinal nematodes in Australia (2009–2012). Australian Veterinary Journal Volume 92, No 12, December 2014.

Smith G, 1990. A mathematical model for the evolution of resistance in a direct life cycle nematode parasite. International Journal for Parasitology, 1990.

Taylor MA, Coop RL and Wall RL, 2016. Veterinary Parasitology, 4th edition. Wiley Blackwell. ISBN 978-0-470-67162-7. http://au.wiley.com/WileyCDA/WileyTitle/productCd-0470671629.html

Whitley NC and Miller J, 2015. Does Diatomaceous Earth Have a Role in Worm Control? International Congress on Sustainable Parasite Management, W4: What Works With Worms was held May 25-26, 2015, at the Farm Inn in Pretoria, South Africa. Accessed January 2017 at https://media.wix.com/ugd/6ef604_42c69fbe0a8b407a8aa36848d2265c2b.pdf

Finding NSW DPI PrimeFacts is easy. Go to www.dpi.nsw.gov.au and search from there, or use your preferred internet search engine and try various search strings. For example, try the following: ‘nsw dpi primefact 55’, or ‘nsw dpi sheep measles’ or ‘dpi primefact 55’. All find the Primefact on sheep measles.

NSW DPI’s information on animal health: http://www.dpi.nsw.gov.au/content/agriculture/livestock/health

WormBoss.com.au / ParaBoss.com.au

WormBoss is an invaluable and highly recommended resource for parasite management, along with ‘siblings’, Flyboss and Liceboss, which are also under the ParaBoss umbrella.

Other

Additionally, seek advice from a veterinarian or other adviser with expertise in livestock parasitology and preferably other aspects of animal health as well.

The searchable database of veterinary chemicals (“PUBCRIS”) at the Australian Pesticide and Veterinary Medicine Authority (APVMA) website is also a useful resource: https://portal.apvma.gov.au/pubcris, or try the APVMA iPhone app: https://itunes.apple.com/us/app/apvma/id564121943

Acknowledgments

Many thanks to those who reviewed this Primefact: NSW DPI Development Officers, **Geoff Casburn** (Wagga Wagga) and **Trudie Atkinson** (Trangie), and **Leonie Martin**, formerly Farm Chemicals Officer, NSW DPI, Orange NSW).

This Primefact is a cooperative venture involving **Local Land Services** (specifically **Hunter Local Land Services**), and **NSW Department of Primary Industries.**

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ISSN 1832 6668

Reference (HP Records Manager): INT17/87735