Cattle worm control in NSW

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This Primefact outlines the basics of worm control for grazing beef cattle in New South Wales.

Cattle worms

Following is an overview of internal parasites ('worms'; endoparasites) of cattle. This includes gastrointestinal nematodes, liver fluke (*Fasciola hepatica*), stomach flukes, and lungworms.

Figure 1. Calf with 'bottle jaw' (submandibular oedema) due to *Fasciola hepatica* (liver fluke). *Haemonchus*, also a blood-sucker, can cause this too. 'Lumpy jaw' ('actino'; usually in older cattle) causes a firm rather than a soft swelling.

Image credit / source: Boray JC, 2017

Round Worms (Nematodes)

Gastrointestinal

Small brown stomach worm (*Ostertagia ostertagi*) is the most important roundworm of cattle in temperate regions worldwide, including NSW.

Other gastrointestinal roundworm species, including barbers' pole worm (*Haemonchus placei*), small intestinal worm (*Cooperia* spp.), stomach hair worm and black scour worm (*Trichostrongylus* spp.), nodular worm and related worms (*Oesophagostomum* spp.), and hookworm (*Bunostomum* spp.), add to the total impact on host animals.

Lungworms

Cattle can be infected with lungworms (*Dictyocaulus viviparus*), but these parasites are usually not a problem in extensively grazed beef cattle in NSW.

Flukes (Trematodes)

Liver fluke (*Fasciola hepatica*) is an important parasite of cattle in certain areas, where conditions are suitable for the intermediate host, an aquatic snail. (The presence of the snail does not necessarily mean fluke are present, however). 'Flukey' areas occur mainly in the eastern third of NSW, but also in some western irrigation areas. More information: Boray, 2017; Love, 2017. (See references).

Stomach fluke (such as *Paramphistomum* spp. or *Calicophoron* spp.) occasionally cause disease, mainly in coastal areas. Adult stomach flukes do little damage; most problems are caused by large numbers of migrating immature flukes in the small intestine, resulting in enteritis, scouring (diarrhoea) and weight loss. More information: Lloyd, 2007.

Coccidia

Coccidia are microscopic protozoal parasites, not worms. The ones of relevance here are the species (e.g. *Eimeria* spp) that inhabit the intestines of grazing livestock, including cattle.

As with sheep and goats, coccidia in cattle occur in the intestines of normal, healthy animals, and coccidian oocysts ('eggs') can be seen during microscopic examination of faeces from animals, as in a 'WormTest' (faecal worm egg count, or WEC).

When disease (coccidiosis) due to large numbers of coccidia occurs, it is often in young animals that are stressed, and in wet, overcrowded conditions. Signs include weight loss and scouring, sometimes with the passage of blood as well as faeces (dysentery). However, similar signs can be seen in scours due to bacteria, viruses, or worms.

Note that drenches for worms (anthelmintics) are not effective against coccidia. Antimicrobials such as sulphonamides are required. Seek veterinary advice.

Table 1. Harmful cattle worms and their distribution (Source: Love and Hutchinson 2003, adapted from Cole 1986)

Common/significant - NSW
Summer rainfall / subtropical areas e.g. North Coast
Haemonchus placei (barber's pole worm)
Ostertagia ostertagi (small brown stomach worm)
Cooperia punctata – C. pectinata (intestinal worm), as a complex, often with *Ostertagia* and sometimes *Bunostomum phlebotomum* (hookworm)
Oesophagostomum radiatum (nodular worm)
Fasciola hepatica (liver fluke) – in 'flukey' areas
Non-seasonal to winter rainfall / temperate areas
Ostertagia ostertagi
Trichostrongylus axei (stomach hair worm)
Cooperia oncophora (intestinal worm)
Fasciola hepatica (liver fluke) – in 'flukey' areas
Occasionally significant, mainly subclinical, or sometimes present in large numbers
Paramphistomum spp. *and Calicophoron calicophorum* (stomach flukes) – especially NSW North Coast (immature stage sometimes imporant). *T. axei* (not of major importance)
Strongyloides spp. (threadworm) (not of major importance)

Integrated parasite management (IPM)

Manage worms by using 'non-chemical' as well as 'chemical' control options. 'Non-chemical' options include improved nutrition and providing 'worm-safe' (low worm-risk) pastures for young cattle.

Immunity and nutrition

Well-fed animals develop immunity faster and are better able to expel parasites and to withstand the effects of those that remain.

Young cattle are most susceptible to worms, but usually develop useful immunity by 20–24 months of age. Generally cattle develop much better immunity to worms than sheep and goats. Although adult cattle often require little or no drenching for roundworms (as opposed to liver fluke), some individual animals can become wormy. Susceptible adults may include bulls, first-calf heifers, and severely-stressed individuals, especially on 'cattle-only' properties in higher rainfall areas.

Pasture/grazing management

'Worminess' of pastures and animals - seasonal patterns

Dung pats can provide shelter for worm larvae for several months, even in very dry conditions. Therefore, paddocks continually grazed in autumn and winter by young cattle - which shed more worm eggs than adults - can become very wormy. The highest numbers of *Ostertagia* eggs are shed by cattle from 6 to 10 months of age, with the numbers falling markedly, due to host resistance, as they approach one year of age. Larval availability (*Ostertagia*) on pasture is highest from late winter until spring, peaking around September, then declining rapidly in summer. Through spring, worm burdens can increase rapidly in young cattle (12-15 months old). Inhibited *Ostertagia* larvae in these young cattle can increase from early spring, peaking in October-February ('pre-type 2 infections'). From late summer to autumn, these larvae in the abomasum can resume development to adult worms in 18 month old cattle, causing severe symptoms of Type 2 ostertagiosis, even when dry weather prevails (Smeal, 1995).

Preparing 'safe' pastures for young cattle

Preparing a number of 'worm-safe' pastures, particularly in higher-rainfall areas of NSW, should be considered. This is so young, susceptible cattle can be moved every few months to paddocks with fewer worm larvae. Aim to graze weaners from late July through to summer on the least contaminated pastures available.

Smeal (1995) advocated preparing 'safe' or 'low worm-risk' pastures for spring 4-5 months beforehand.

Table 2. Low worm-risk pastures for weaners

Rank	Pasture management
Best	New sown pasture or crop
	Pasture spelled or grazed by sheep for previous 4 - 5 months
	Pasture not grazed by any cattle for previous 4 - 5 months
Good	Pasture grazed by adult (>2 years old) dry cattle Pasture grazed by cattle older than 18 months of age
Higher risk	Pasture grazed by young cattle such as weaners

In Smeal's plan for the NSW tablelands (where cool, moist conditions in spring favour *Ostertagia*), there is the option of a Single or Double Paddock Grazing system.

In the **'Single' system**, a 'safe' paddock is prepared between March and July by spelling, or grazing with untreated adult cattle (>2 years old) and / or sheep at low stocking rates. Ten month old weaners are drenched and moved into the 'safe' paddock in late July, where they remain through spring into early summer. Smeal (1995) reports that, in trials where 'safe' grazed weaners were compared to those remaining on pastures contaminated in autumn and winter, the former had significantly lower worm burdens, as well higher weight gains - 30-60 kg extra per head - by spring and early summer, 9-12 months after weaning.

In Smeal's **'Double' system**, two 'safe paddocks are prepared for 4 months over autumn/winter (April-July), in the same way (using adult cattle etc.) as the Single system. The combined area of the two paddocks is equivalent to that used in the Single system. In July, weaners are drenched and moved to the first paddock for 8-10 weeks (until late September / early October), or until abundant high quality feed is available in the second 'safe' paddock. After being drenched and moved to the second paddock, the young cattle remain there until December, at which time they return to the first, which has not been grazed since September.

According to Smeal (1995), live weight gains in the Double system are low initially, due to the higher stocking rate and a relatively low plane of nutrition, but trials showed heifers and steers were 40-70 kg per head heavier by December compared to cattle run on contaminated pasture under more traditional management systems.

Smeal states these grazing systems have been highly effective in reducing numbers of *Ostertagia ostertagi* and other nematodes over whole farms after 1 to 2 years, and says they should be used in 'wormy' environments' if cattle raising is a major enterprise. He also noted (in 1995) that beef producers in eastern parts of the northern tablelands have successfully used the Double Paddock Grazing System since 1978.

But, for many if not most beef producers, regular use of relatively long-acting endectocides is more attractive than using grazing management and short-acting drenches. Endectocides (macrocyclic lactone-based pour-on (topical) drenches with activity against endo- as well as ectoparasites) have certain advantages. In weighing up the options, even an informal benefit-cost analysis would have to include issues such as sustainability and selection for resistance, a matter on which opinions will vary, as well as production gains per unit input (cost of drench, labour, other management costs); in short, productivity.

'Drench and move' and 'refugia'

Note that drenching cattle immediately before or after moving onto very clean pasture, for example ungrazed cereal stubble, can result in greater selection for resistant worms. This is because there are few worms 'in refugia' on the clean paddock relative to worms remaining in the cattle. So, there are fewer drench-susceptible worms to 'dilute' the progeny of resistant worms surviving the drench. 'Safe' pastures (as described here) in tablelands areas, for example, will likely have more worms in refugia than ungrazed cereal stubbles.

More information: See "Refugia" in References.

Diagnostic tests

Worm egg counts (WECs) – roundworms

Faecal worm egg counting (WEC) is the old standby for diagnosing worm problems in grazing livestock. Compared to sheep and goats, its usefulness in cattle is a little limited given that egg counts do not always give a good indication of worm burdens in beef cattle beyond weaning (6-8 months old), especially as they near one year of age.

A high egg count is significant, but production losses and even clinical disease due to worms can sometimes occur when egg counts are low, for example, as low as 50 eggs per gram of faeces (epg) (Eppleston and Watt, 2011; Rolls and Webb Ware, 2011).

Despite its limitations, worm egg counting on the day of drenching, and again 14 days later (i.e. a 'DrenchCheck'), is a useful way to check drench efficacy.

Pepsinogen

Sometimes the 'pepsinogen' test is used in tandem with WECs. This test may detect damage to glands in the abomasum (4th stomach) due to *Ostertagia* (brown stomach worm), and possibly *Haemonchus* (barber's pole worm).

Post-mortem examination

Parasites, especially larger ones like liver fluke, can be seen at post-mortem. However fine hair-like roundworms like *Ostertagia* (small brown stomach worm) and others might be harder to see, especially if vision is not 20/20 and the light is poor. (Sometimes vets and others in the field stain gut contents with iodine, then decolourise the debris with 'hypo' (sodium thiosulphate, or sod. hyposulphite), then examine the contents against a white background. The stained worms are then easier to see. This field method is a 'rough and ready' version of the worm counting procedure done in the lab (Taylor and others, 2016, pages 270-271).

Tests for liver fluke

These include:

Fluke egg count

A count can be done using a flotation technique in the lab (as used with roundworm eggs), employing the right (sufficiently dense) solution. More usually a sedimentation technique is used. The *Fasciola* (liver fluke) eggs need to be differentiated from paramphistome (stomach fluke) eggs which are similar in appearance.

The sensitivity (ability to detect true positives) of the test is not high, about 50-80%. Also the test does not become positive until about 2-3 months after infection, when the fluke have matured and started to produce eggs. The test becomes negative about 2-3 weeks after successful treatment.

Serum antibody ELISA

This test detects antibodies that animals develop in response to a liver fluke infection. These antibodies are to different parts or products (antigens) of the fluke. This test is more sensitive (70-90+ %) than the fluke egg count, and becomes positive about 4 weeks after infection. However, antibodies can remain detectable for up to 12 weeks or more after successful treatment for fluke.

Copro-antigen ELISA (faecal fluke antigen ELISA)

This relatively new test – based on a European test kit - detects enzymes produced by liver fluke. The test has shown high sensitivity (few false negatives) and high specificity (few false positives) and detects infections 2-4 weeks before eggs appear in the faeces. Put another way, it generally detects fluke in cattle and sheep from 6-9 weeks post-infection, i.e. about the time fluke arrive in the bile ducts. Coproantigen levels in samples collected at different times from individual animals can vary 2-6 fold from day to day. A similar day-to-day variation occurs with fluke egg counts.

More information: Love S, 2017 (Liver fluke).

Monitoring clinical signs and productivity

If, for example, an animal has bottle jaw, or generally appears unthrifty or its (measured) weight gains are less than expected for the plane of nutrition it is on, then that could well mean worms are an issue, even if worm egg counts are low. One option to clarify things is a 'diagnostic drench'.

'Diagnostic drench'

If you think a mob of cattle may be wormy, but are not sure, consider drenching a proportion and monitoring the response, which optimally includes objective measurement, of weight gain, for example. It also helps if the drench used has previously been tested and found to be effective on the property against the worms that are usually the problem.

More information on diagnostic tests: See 'State Veterinary Diagnostic Laboratory – NSW DPI' in References.

Drenching

For more on the timing and frequency of drenching, see the section, 'Putting it all together', towards the end of this PrimeFact (page 9 and following).

Roundworms

Anthelmintic treatments to control round worms are usually needed in young cattle in higher-rainfall areas (or irrigated pasture/crops) of NSW: the coast, tablelands, and slopes, i.e., the eastern third of the state (where annual rainfall tends to be >500-600 mm). Beef cattle on pasture are most affected by worms in the 3-6 months after weaning, which, in spring-calving herds, is often carried out in autumn, when calves are around 8 months of age.

One to three broad-spectrum drenches (for roundworms) may be required, the first at weaning. Depending on the 'worm challenge', an extra 1-2 drenches in the 6 months after weaning may be required.

If one of these is an effective drench given in late spring / early summer, this may also serve to prevent 'type 2 *Ostertagia* disease' ('type 2 ostertagiosis') in weaners-yearlings retained on the property).

Higher 'worm challenge' may occur on properties where:

- rainfall is high e.g. somewhat higher than 1000 mm p.a.
- the farm is a cattle-only enterprise, and heavily stocked
- a relatively high proportion of the herd are young cattle (e.g., less than 18 months old)
- grazing management aimed at producing low worm-risk ('safe') paddocks for weaner cattle is not practised, for whatever reason
- ineffective drenches are inadvertently used
- nutrition is less than optimal

Low rainfall areas – the rangelands of NSW

In low-rainfall areas of western NSW (the pastoral zone or rangelands), drenching of cattle of any age is rarely required. (If in doubt, begin by checking young cattle using a worm egg count).

For most of NSW, regular treatment of adult cattle for round worms is not required, with the possible exception of a drench for bulls before joining and, in higher 'worm challenge' environments, first calf heifers. However, individuals within a mob of adults may get wormy and require treatment.

Fluke

On liver fluke-affected farms, treatment of all cattle (normally weaners and older) with a flukicide will be required one or more times a year, depending on the severity of the problem. The most important liver fluke treatment is usually in late autumn (April/May) when both immature and adult flukes are present. Some flukicides are only effective against adults, and perhaps late immatures. Consider rotating from one flukicide type to another in order to slow the development of resistance.

Note the restrictions on using flukicides containing triclabendazole in lactating dairy cattle.

Stomach fluke can affect cattle under certain conditions, particularly in coastal areas.

More information: Lloyd J, 2007 (stomach fluke); Love S, 2017, and Boray J, 2017 (liver fluke).

Drench types

See Table 3.

For more detailed information, see PUBCRIS at the APVMA website:

https://portal.apvma.gov.au/pubcris

Information on drenches for cattle may also be available at WormBoss (wormboss.com.au) by 2018 or 2019.

Table 3. Drenches for cattle worms – an outline

Drench family/active constituent(s)	Brand names – examples
Broad-spectrum roundworm drenches: benzimidazole ('BZ', 'white')	
Albendazole	Strategik, Valbazen
Fenbendazole	Fencare, Panacur
Oxfendazole	Systamex, Oxazol
Broad-spectrum roundworm drenches: levamisole ('LEV', 'clear')	
Levamisole	Nilverm, Rycozole, NuLev
Broad-spectrum roundworm drenches: macrocyclic lactones ('MLs', 'mectins')	
Abamectin	Avomec, Paramectin, Virbamec
Doramectin	Dectomax
Eprinomectin	Ivomec Eprinex
Ivermectin	Ivomec, Paramax, Bovimectin
Moxidectin	Cydectin
Combination: two or more broadspectrum actives	
Abamectin + levamisole	Eclipse (pour-on)
Abamectin + levamisole + oxfendazole	Trifecta (oral)
Broadspectrum + flukicide(s)	
Abamectin + triclabendazole	Fasimec (pour on), Genesis Ultra (pour on)
Ivermectin + clorsulon	Ivomec Plus, Virbamec Plus, Genesis Ultra (injection)
Ivermectin + clorsulon + nitroxynil	Nitromec
Ivermectin + triclabendazole	Sovereign, Triclamec, Fasimec (oral)

Drench family/active constituent(s)	Brand names – examples
Levamisole + oxyclozanide	Nilzan LV
Oxfendazole + triclabendazole	Flukazole
Broadspectrum + 'tickicide' (acaricide)	
Ivermectin + fluazuron	Acatak Duostar
Flukicide(s)	
Clorsulon + nitroxynil	Nitrofluke
Triclabendazole	Fasinex, Tremacide, Flukare

Notes – Table 3: Next page
Brand names: the examples above are chosen randomly. More information: https://portal.apvma.gov.au/pubcris
Brand names can be confusing. Some products with similar or the same names may have different active ingredients, e.g. Fasimec, and Genesis Ultra. Always check, read and follow product labels. Note withholding periods (WHPs) and export slaughter intervals (ESIs).
Some products are still registered but no longer available, e.g. Trodax (nitroxynil).
Some endectocides (able to kill ('cide') internal ('endo') as well as external ('ecto') parasites) may have activity against ticks etc. Indeed, some 'mectin' (macrocyclic lactone, 'ML') products are used for cattle tick (*Rhipicephalus (Boophilus) microplus*) control in some situations. Be mindful, however, of selection for resistance in other parasites: cattle worms, for example.
In Australia, anthelmintics ('drenches', less commonly, 'wormers') for livestock may come in different formulations and with different modes of administration: oral, pour-on (backline, topical), injectable, or slow-release (oral capsule) formulations.

Drench resistance

In an earlier worldwide review of anthelmintic or drench resistance in cattle worms, Hutchinson (Australia, 2003) stated that evidence for resistance in cattle worms was only slowly coming to light and had so far been restricted to the less-pathogenic species, *Trichostrongylus axei (stomach hair worm)* and *Cooperia spp* (small intestinal worm). However, he added that it was likely that resistance to macrocyclic lactones (MLs) would become established in Australia.

Kaplan (USA) in 2004 said there were proven cases of cattle nematodes resistant to benzimidazole (BZ) and macrocyclic lactone (ML) drenches in other parts of the world: *Haemonchus* and *Cooperia* in Argentina (Anziani et al 2004); and *Cooperia* in Europe (Coles 2002).

New Zealand

In New Zealand there were reports from the early 1990s of resistance to BZs, principally in *Cooperia* but also in *Ostertagia* and *Trichostrongylus* (Hosking & Watson 1991, McKenna 1996). ML resistance was reported in 1996, again mainly in *Cooperia* (Vermunt et al 1996).

Waghorn and others (2006) conducted a study in New Zealand using a faecal worm egg count reduction test (WECRT) for ivermectin, levamisole and albendazole on 60 calves on each of 62 randomly selected farms in the North Island. Resistance to an anthelmintic was inferred when there was <95% reduction in faecal worm egg count (FEC or WEC) 7–10 days after treatment.

Of the farms that completed the WECRT, 4/61 (7%) showed ≥95% reduction in WEC for all anthelmintics tested. Resistance to ivermectin was evident on 56/61 (92%) farms, to albendazole on 47/62 (76%) farms, and to both ivermectin and albendazole on 45/61 (74%) farms. Resistance to levamisole was evident on only 4/62 (6%) farms. The parasites most prevalent in resistant populations cultured were *Cooperia* spp. On 45/61 (74%) farms where *Cooperia* spp were present in sufficient numbers, resistance to both ivermectin and albendazole was evident. No cases of levamisole-resistant *Cooperia* spp were detected. Resistance of *Ostertagia* spp to ivermectin was evident on 4/45 (9%) farms, to albendazole on 15/46 (35%) farms, and to levamisole on 4/46 (9%) farms.

Risk factors for anthelmintic resistance were examined in a concurrent interview and questionnaire of NZ farmers' opinions and practices (Jackson et al 2006). This revealed that the median number of treatments annually was five. One in four farms used anthelmintics on calves on 8–12 occasions in their first year of life, a much higher frequency than would ever be considered under Australian conditions. Most anthelmintics used for the previous five years were MLs or ML-based combinations, rather than BZs, LEV or BZ/LEV combinations (Jackson et al 2006).

Many cattle producers, although aware of drench resistance, did not perceive it to be a major problem in cattle. The authors concluded that all cattle farms should now be using combinations on most occasions to achieve effective control of all parasites.

Another study (Mason and McKay 2006) investigated the efficacies of pour-on anthelmintics on five New Zealand farms with suspected resistance. The study was against field strains of parasitic nematodes in young cattle. Resistance to IVM and eprinomectin (EPI) was found in *Cooperia oncophora* on all farms. There was emerging resistance of *Ostertagia* to IVM, but not EPI. In other (short-tailed) *Cooperia* species there was resistance to both IVM and EPI; and in *Trichostrongylus* there was resistance to IVM, EPI and LEV used separately. At the time, the authors concluded that simultaneous administration of LEV and IVM pour-on was likely to control both ML-resistant *C. oncophora,* and stages of *Ostertagia* that were not controlled by LEV.

(*Currently there are two combination (as defined in this Primefact) cattle drenches in Australia: see Table 3).*

Australia

Until the current millennium, Australia has had only two to three confirmed cases of drench resistance in cattle, both involving BZ ('white') drenches. One case involved oxfendazole-resistant *Trichostrongylus axei* (stomach hair worm) in western Victorian cattle (Eagleson and Bowie 1986). The other was oxfendazole and febantel-resistant *T axei* in the New England region of NSW (Eagleson et al. 1992). For context: the BZs, beginning with thiabendazole, came onto the market in Australia in the 1960s.

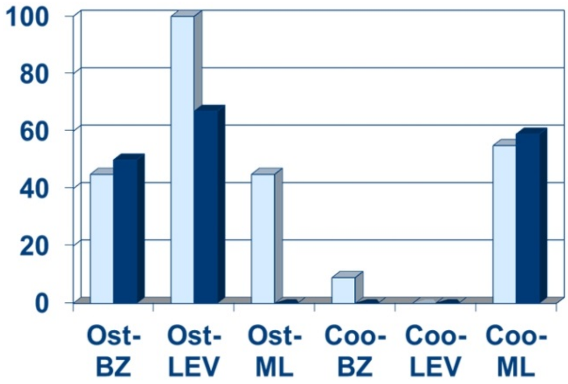
Anderson and Lord (1979) also reported thiabendazole and levamisole resistance in *Ostertagia ostertagi* in cattle.

In 2010, Lyndal-Murphy and others confirmed drug-resistant cattle worms in south east Queensland, the first Australian report of macrocyclic lactone (ML) drenches failing against subtropical small intestinal worms (*Cooperia* spp) in cattle, and possibly also barber's pole worm (*Haemonchus placei*).

More recently in Australia, Rendell (2010) and Cotter and others (2015), reported survey work using faecal worm egg count reduction tests (WECRTs) to monitor efficacy of different drenches against roundworms of cattle.

The findings are summarised in figure 2.

Figure 2. Cattle roundworm resistance: two Australian surveys in the period 2006-2011. Percentage of farms with resistance. Rendell (2010) and Cotter et al (2015).



Notes: **Victoria** (Rendell, 2010. 13 farms): **pale blue** columns, south west **Western Australia** (Cotter and others, 2015. 19 farms): **dark blue**.
Farms surveyed for resistance of cattle worms to anthelmintics. Test used: faecal worm egg count reduction test. **Ost**(ertagia) = small brown stomach worm. **Coo**(peria) = small intestinal worm. **BZ** = benzimidazole ('white'). **LEV** = levamisole. **ML** = macrocyclic lactone ('ML', 'mectin'). Oral formulations used except in WA where, in the case of ivermectin, an injectable formulation was used and, on separately grazed treatment groups, a pour-on formulation was used. Resistance here is defined as <95% faecal worm egg count reduction (F(W)ECR) post-treatment. Cotter and others (2015) also noted "an indication (of) reduced efficacy of the pour-on ivermectin formulation compared to the injectable was apparent against both *Cooperia oncophora* and *Ostertagia ostertagi*, and this may have implications for resistance development, given the widespread use of topical treatments reported in this region". The WA trials were done in the years 2010-2011 (on weaned beef cattle, 6-15 months old); the Victorian trials in 2006-2009 (on 'calves', 4-10 months old).

ML-resistant *Ostertagia*: NZ, Australia and elsewhere

Ostertagia ostertagia (brown stomach worm) is a particularly important roundworm of cattle in temperate regions of the world, so reports of it being resistant to drenches usually command attention.

In 2016, Waghorn and others confirmed ivermectin resistance in *Ostertagia ostertagi* in cattle in New Zealand. They said that, until recently, reports of resistance in the highly pathogenic *Ostertagia ostertagi* (Herlich, 1959) have been rare (Sutherland and Leathwick, 2011), but that cases have now been documented in the United States of America (Edmonds et al., 2010), Europe (Demeler et al., 2009; Geurden et al., 2015) and Australia (Rendell, 2010), and that resistance is suspected to be developing in Argentina (Suarez and Cristel, 2007). They go on to say that, in New

Zealand, there have been anecdotal reports, and a number of anomalies in efficacy tests (Mason and McKay, 2006; Waghorn et al., 2006; McAnulty and Gibbs 2010), which might have indicated emerging ML resistance in this parasite. But, **none of these suspect cases had been confirmed, for example by slaughter studies**, as involving resistant parasites.

However, Waghorn and co-workers (2016) confirmed this (ML-resistance in *Ostertagia*) by slaughter studies (worm counts) as well as faecal worm egg count reduction tests. The authors also found cases of *Ostertagia* resistant to albendazole. In all cases, levamisole was less than 95% effective. However, they found that moxidectin given orally was effective against all isolates tested.

Risk factors for resistance?

Some factors which may increase selection of resistant worms include:

- increased exposure of the worm population to anthelmintics (through frequent drenching and/or use of long-acting drenches)
- exposure of worms to sub-lethal doses of anthelmintics (through under-dosing, or poor application, or during the 'tail' of long-acting drenches (when blood and tissue levels of the drench active are declining))
- unnecessary drenching of immune animals (adults) (Strong host immunity reduces the ability of relatively unselected worms to establish in host animals and compete with resistant survivors of a drench)
- drenching unnecessarily in dry seasons or dry environments when there are very few worm larvae on pasture (few worms 'in refugia'). (Note, however, that cattle worm larvae can survive for some time in the protected conditions of a dung pat, unlike in sheep faecal pellets).

In many areas of NSW, especially drier areas, cattle are drenched too often, particularly adult cattle. (Seek local expert advice on how much drenching is required. Some on-farm experimentation may be required).

Why so much discussion of resistance?

This has been discussed in some detail because many producers and advisers are still not sufficiently aware that resistance of cattle worms is now a common and significant issue and not merely a problem for sheep and goat producers.

Drench resistance, like the worms themselves, is largely invisible, unless testing is done. But the costs, mainly occurring as loss of production, which may go unnoticed, can be considerable.

Quarantine drenching

When introducing cattle from other properties, consider 'cleaning them out' with a 'quarantine' drench, at least for **roundworms**, and possibly also for **liver fluke**.

Almost certainly a combination broad spectrum drench, i.e., one containing two more or unrelated actives, will be required. An alternative is to drench (on the same occasion) with single active drench A, followed by unrelated single active drench B, and so forth. Expert advice will be required as the resistance situation is evolving. If treating for liver fluke, also consider using a fluke product that contains two or more unrelated flukicides, or sequentially treating (same day) with two or more unrelated flukicides.

After treatment, retain animals on a 'quarantine' paddock (a good biosecurity practice in general) before releasing onto the rest of the farm. Regarding roundworms, it may take up to 3-4 days for all worm eggs to pass out of the animal's digestive tract. The time for passage of fluke eggs is longer, up to 2-3 weeks, as fluke eggs can be retained in the gall bladder for a time.

Time in 'quarantine' will be longer if you intend to do tests to make sure the drench(es) worked. In the case of round worms, a worm egg count is done on the day of treatment (day 0) and again 14 days latter to gauge the effectiveness of a drench. This is commonly called 'DrenchCheck'.

For liver fluke, the time depends on what test is used. If doing a fluke egg count, the test is done on day 0 and again 21-28 days later. The coproantigen ELISA (faecal fluke antigen ELISA) can be done earlier, possibly as early as day 14. (Some suggest as early as 7-10 days after treatment).

Consider other biosecurity issues as well, including other animal health issues, plant pests etc.

More information: http://www.dpi.nsw.gov.au/biosecurity and see Love S (2016). 'Quarantine….' in References.

Fine tuning

In consultation with your adviser, fine-tune an integrated parasite management program to suit your property. Use WormTest (faecal worm egg counts (FECs or WECs) to monitor worm burdens, and also drench efficacy (DrenchCheck).

Cattle (especially adult cattle) are sometimes drenched too often. WormTest, along with measures of productivity (e.g. weight gain), can help with decisions about drenching. However, as stated earlier, WECs can be an unreliable indicator of actual worm burdens in cattle – especially cattle older than 9–12 months.

In yearling or adult cattle that appear to be wormy but have low worm egg counts, consider a 'diagnostic drench', that is, drenching a small number of cattle in the mob and monitoring the response to treatment.

Clinical disease or reduced performance can sometimes be present when egg counts are very low.

Putting it all together

Table 2 below gives an example of a cattle worm control program. Remember that cattle in many areas of NSW, mainly those with lower rainfall, will require fewer treatments than are included here. Some (e.g., with rainfall >> 1000 mm), particularly if cattle-only properties, may require more.

Table 4. A guide to cattle worm control - NSW tablelands (spring calving - September)

Age group or management	Jan (Joining)	Feb-March	Apr/May (Weaning) (6-8 m.o.)	Jul-Aug	Oct-Nov	Dec
Weaners			✓	(✓) Move to 1st 'safe' paddock if prepared	(✓) Move to 2nd 'safe' paddock if prepared	
Yearlings (16-18 months)	(✓) (Jan-Feb)					
1st calvers				(✓) (pre-calving)		
Bulls						✓ (pre-joining)
All weaned cattle – liver fluke		(F3)	(F1)	(F2)		
Low worm-risk pastures			Start (April) preparation of 1st 'safe' paddock for weaners	Start (Jul) prep. of 2nd 'safe' paddock for weaners		

Notes

This is a generic guide for NSW tablelands areas. Other areas: see notes below.

✓ denotes am effective broad-spectrum treatment (for roundworms) given each year. For cattle properties that require regular broad-spectrum treatments each year, **the most important is the drench for weaners at weaning**.

The most important roundworm of cattle in temperate regions of the world is *Ostertagia ostertagi* - small brown stomach worm. Numbers of *Ostertagia* larvae on pasture in the NSW tablelands peak from late winter to spring. On the north and central coasts of NSW, the peak is a little earlier: late autumn into winter (Anderson and Waller, 1983)

(✓) denotes an optional broad-spectrum drench. Some properties will require more than the 'bare minimum drenches' (denoted by ✓). Properties in higher rainfall areas (>1000mm pa) may require more of the optional drenches listed, especially if 'cattle-only' properties. Fine-tuning will be required, aided by worm egg counts (WECs), fluke egg counts (and/or fluke antibody or antigen tests), and regular measurement of productivity (e.g. growth rates). Note that WECs in cattle do not correlate so well with actual worm burdens once cattle are over 9-12 months of age. High WECs are significant; low or zero WECs may not preclude the possibility of parasitism, whether clinical (with signs of 'worminess'), or sub-clinical (production losses). Productivity data helps here, as does response to a diagnostic drench. (See main text).

Signs of 'worminess' include **anaemia and bottle jaw** (caused by the 'blood suckers': *Fasciola* - liver fluke; *Haemonchus* - barber's pole worm, especially subtropical areas, e.g. NSW north coast), and **scours/ill thrift** (caused by *Ostertagia* and other worms). Adult cattle generally acquire relatively good immunity to roundworms and require few if any broad-spectrum drenches, but some individuals do get wormy and require treatment. Adult cattle, on 'flukey' farms (as well as weaners and yearlings) still require treatment for 'fluke'

Drenches: use effective drenches. Remember drench resistance appears to be becoming more common. Regularly check drench efficacy (DrenchCheck): a WEC on the day of drenching, and again 14 days later.
Drenches for weaners: in tablelands regions, after the weaning drench (Apr/May, assuming a spring calving), 1-2 additional broad-spectrum drenches at 3 monthly intervals may be required. This varies a lot, depending on various factors, including climate/rainfall, type of enterprise, effectiveness of drenches, whether short-or long-acting drenches are used, nutritional status, and whether grazing management is used (preparation of low worm-risk paddocks for weaners). Regarding long-acting drenches, remember that frequent use, especially 'back-to-back' use, may result in increased selection for drench resistant worms, as can overly frequent use of short-acting drenches, and drenching and moving immediately to very clean paddocks (e.g. cereal stubble).
Type 2 Ostertagia disease (ostertagiosis): This is caused by a more or less synchronised resumption of development of 'hypobiotic' (inhibited development) *Ostertagia* larvae in the lining/glands of the abomasum (4th stomach). It is thought that cold-exposed larvae on pasture (winter/early spring), that are ingested at that time, are inclined to go into a state of hypobiosis for a few months. 'Type 2 disease' in NSW tends to occur in young cattle's second summer, at about 15-18 months of age, although it can occur at other times/ages. The prevalence of type 2 disease seems to have declined somewhat since the introduction in the 1980s of macrocyclic lactone (ML) drenches, which are effective against inhibited (as well as adult) *Ostertagia*. However, resistance of worms to those and other drenches is increasing, so the prevalence of type 2 ostertagiosis could increase too.
Weaners that are going to be retained (e.g. as replacement heifers) may require treatment in mid-late spring (e.g. Sept or Oct) with a drench effective against *Ostertagia* including inhibited larvae. An ML- based drench (a single active drench or combination drench) is likely to be the best choice, unless rendered less than effective by resistance.
Smeal on drenching weaners. Smeal (1995) suggests the following treatments for weaners in NSW tablelands herds with spring calving: [1] Treat at weaning (April/May) and move to a fresh paddock. To keep worm egg output low during winter and early spring, treat twice more: [2] 4 weeks after the drench at weaning, and [3] in late July. In some parts of the eastern tablelands, parasite transmission may continue into summer, due to cool, moist conditions, and a fourth (4) treatment may be required, this one in December. A macrocyclic lactone-based drench is advocated at this time because of their efficacy against all stages of susceptible *Ostertagia*. This outline of Smeal's (1995) scheme (3-4 drenches) assumes the use of short-acting drenches. Fewer drenches will be required if using effective long-acting drenches and/or 'worm challenge' is lower.
Grazing management – low worm-risk paddocks for weaners: Smeal (1995) and others advocated the preparation of 'safe' (low worm-risk) paddocks for weaners, with preparation time being ~ 4 months. For example, weaners would move into a 'safe' paddock in July, with this paddock being prepared by having no young cattle (<2 years old) grazing that paddock from April. Worm numbers build up over autumn and winter when they are continuously grazed by weaners, so moving weaners to a 'safe' paddock in July can markedly improve worm control. A second paddock can be prepared for weaners to move into in Spring (e.g., Oct-Nov). Smeal promoted two variations on grazing management: a **Single Paddock System** and a **Double Paddock System** (see main text). Grazing management requires planning, even for just one paddock (for weaners in July), so some producers opt for long-acting drenches, or giving extra short-acting drenches. However, undue reliance on long-acting products (especially if 'back-to-back'), as well as frequent drenching, could increase selection for drench resistance. Drenching and moving weaners into 'safe' or 'clean' paddocks could also potentially increase selection for resistance, because there are relatively few worms in refugia on the 'safe' paddock. Be aware of the issues and discuss the advantages and disadvantages of the various approaches with you adviser.
Liver fluke: Properties with liver fluke will require at least one strategic fluke drench a year, with this happening in April/May (1st fluke drench: F1). The most effective flukicides (killing adults as well as early and late immatures) should be used. Some properties will require a 2nd treatment (F2) in Aug/Sept, and others may even require a third (F3), this being given in Jan-Feb. Be aware there are strains of fluke resistant to fluke drenches.
Stomach fluke (paramphistomes): Although adult paramphistomes have very little effect on cattle, migrating juveniles (travelling through the small intestine, heading for the stomachs) can cause disease if present in large numbers, especially in young cattle. This situation occurs at times on the NSW north coast, for example. (Get good local advice on treatment. Also see Lloyd, 2007).
Other parts of NSW?
Western NSW: Routine drenching of cattle of any age in western NSW is unjustified in most cases.
Eastern NSW: In the eastern third of NSW, with higher annual rainfall (e.g., >500-600mm) and often a more temperate climate, routine drenching for roundworms is required in most cases (to prevent ill health and significant production losses), with the bare minimum being a drench for weaners at weaning. Some farms may need no more than this. Adult cattle (>2 years old) generally develop good immunity to worms and in most cases do not require routine drenches. Treating bulls pre-joining may be justified, and is not a major cost overall, and may not contribute much to development of drench resistance. In areas with high worm challenge (e.g. cattle-only farms with rainfall >>1000mm pa), a routine treatment to 1st calf heifers may also be necessary. 'Flukey' farms require treatments of all age groups (including sheep, goats, alpacas) with appropriate flukicides.
Why not a set program for each region? Adult cattle (>2 years old) develop better resistance to worms than do sheep and goats. This is a plus. Most of the worm impacts are in young cattle (< 2 years), especially those less than 18 months old. A challenge with worm control in cattle is that worm egg counts, although still useful, are not such a good guide to actual worm burdens, unlike the situation with sheep and goats. This makes it much harder to fine-tune a program in cattle. Also there are large variations from farm to farm, even within a locality, when it comes to 'worm challenge'. Some experimentation is required. Independent, locally relevant expert advice helps. To assess worm impacts, worm egg counts, along with regular visual assessment of animals, and measuring productivity (e.g. weight gains), is required. (If you don't measure it, you can't manage it).

MLA's cattle parasite atlas: Also consult MLA's guidelines on cattle parasite management. It has different plans for different regions of Australia

A rule of thumb: genetics aside, the two most important causes of ill thrift in grazing livestock are parasites and poor nutrition. In the case of parasites, certainly internal parasites, the biggest cost most often is from production losses, which may be quite substantial, but sometimes unnoticed.

References and more information

See related Primefacts on the NSW Department of Primary Industries website: www.dpi.nsw.gov.au/primefacts

Also see WormBoss (wormboss.com.au). Currently it contains information relating to sheep and goats. Information on cattle worm control will hopefully be available in 2018 / 2019.

Consult the 'Cattle Parasite Atlas' at the MLA website: https://www.mla.com.au/CustomControls/PaymentGateway/ViewFile.aspx?CBSGoUKScHlFpDxts9F1BXR1zhSqeOSm5uhX8cawsZb4Hq10A8j9tgBF83sXk9OF3EYMKKAfsht7d1Tnt3BqiA==

Or try this shortened URL to reach the Atlas: http://preview.tinyurl.com/yawkmo3w

Farm biosecurity

Some resources on biosecurity, in no particular order:

Farm Biosecurity Planning. Northern Tablelands Local Land Services: https://northerntablelands.lls.nsw.gov.au/resource-hub/publications (One of the good features of this resource: lots of practical/nitty-gritty advice).

Biosecurity & LPA – Meat and Livestock Australia. MLA's long URL: https://www.mla.com.au/meat-safety-and-traceability/red-meat-integrity-system/about-the-livestock-production-assurance-program/seven-lpa-requirements/biosecurity/ or, use this shorter one: http://bit.ly/2v4qIjr

Biosecurity pages- NSW DPI: http://www.dpi.nsw.gov.au/biosecurity

LBN – Livestock Biosecurity Network: http://www.lbn.org.au/farm-biosecurity/

According to LBN, "Biosecurity refers to ... measures that guard against animal and plant diseases and pests. Biosecurity ..(combines)..the management of risks to the economy, the environment, and the community, of pests and diseases entering, emerging, establishing or spreading. Biosecurity measures can be implemented off-shore, at the border and on-farm."

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

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For updates go to www.dpi.nsw.gov.au/factsheets

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