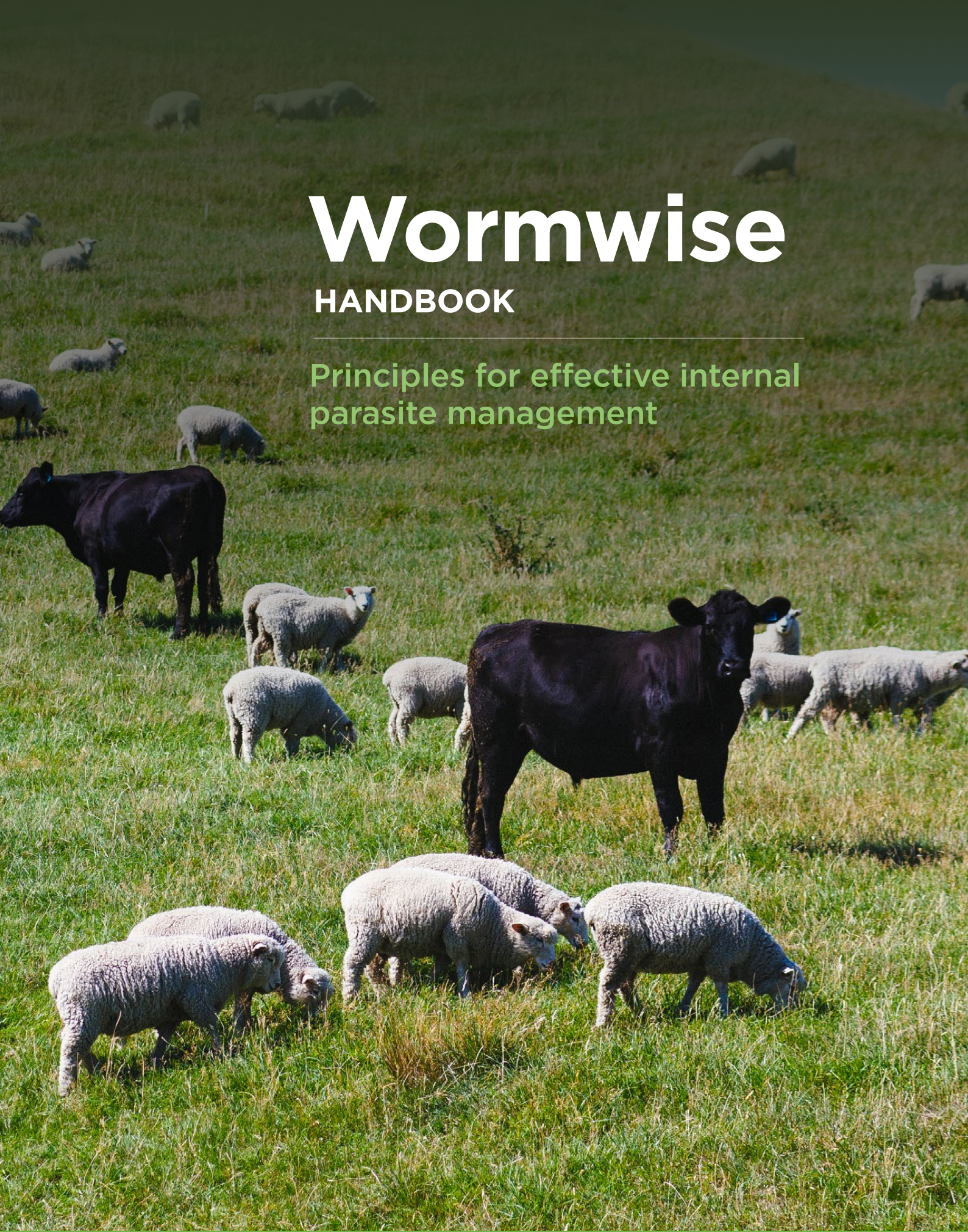


Wormwise

HANDBOOK

Principles for effective internal parasite management

wormwise
Funded by Beef + Lamb New Zealand

beef+lamb new zealand

Ministry for Primary Industries
Manatū Ahu Matua

animal & plant health
NEW ZEALAND

NZVA
New Zealand Veterinary Association
Te Pae Kīrehe

Why Beef + Lamb New Zealand Wormwise?

For at least two decades, farmers have identified the sustainable management of worms (internal parasites) as one of the biggest challenges they face.

They have asked for consistent messages on testing, drench selection, farm policies, grazing management and genetic solutions to worm problems.

In May 2005, Beef + Lamb New Zealand (formerly Meat and Wool New Zealand) and MPI (formerly MAF) Sustainable Farming Fund initiated the development of a national worm management strategy, named Wormwise, involving all stakeholders. The strategy was completed in December 2005.

Wormwise Workshops and Factsheets were early outputs from the programme.

In September 2014, Wormwise established a website to be the central repository of information on internal parasites on New Zealand pastoral farms.

A review of Wormwise in 2020 saw the employment of a Programme Manager, with an increase in direct-to-farmer communication, including social media, regular rural press articles, and a new website. As well as communicating directly with farmers, Wormwise also works to upskill veterinarians and other rural service providers.

Beef + Lamb New Zealand Ltd is currently the sole funder of Wormwise.

For more information see **www.wormwise.co.nz**

Access all Wormwise information and resources

Contents

Acknowledgements

Chapters 1,2: Robin McAnulty & Trevor Cook.

Chapters 3-7: Ginny Dodunski & Mary Bowron.

With thanks to the members of the Wormwise Technical Advisory Group: Dave Leathwick, Andrew Greer, Anne Ridler, Kathryn McRae, Ian Scott, Paul Mason & Clive Bingham.

RB22. March 2026

wormwise

Funded by Beef + Lamb New Zealand

beef+lamb new zealand

Ministry for Primary Industries
Manatū Ahu Matua

animal & plant health NEW ZEALAND

NZVA New Zealand Veterinary Association Te Pae Kirehe

Wormwise principles for effective internal parasite management

We have to learn to live with worms

Healthy animals harbour worms and always will—eradication is neither an appropriate goal nor an achievable one. Most of the year there are more worms, in the various life stages, on pasture, than inside the animals.

Whilst every farm is unique, and effective worm management plans will vary between farms, some key principles apply across all situations.

The first two chapters cover the effects of worms on livestock, and worm biology. The following chapters are all about actions that can be taken to better manage worms, covering: F.A.R.M.ED - Feeding; Avoiding the worms; Refugia; Monitoring; Effective Drenching.

Feeding

Think Wormwise, think
F.A.R.M.ED

Good nutrition greatly enhances animals' ability to deal with worms.

Well-fed animals are less affected by worms than those under nutritional stress.

Growing out young stock quickly reduces the length of time that they are susceptible to worms and can reduce the amount of drench needed in a farm system.

Avoiding the worms

Think Wormwise, think
F.**A**.R.M.ED

Avoid exposing susceptible animals to high pasture contamination.

An effective worm management plan will have a strong focus on reducing pasture contamination and its impact on stock.

Generally, worm development is in proportion to pasture growth. Warm, moist conditions speed parasite build-up; cold slows development; dry weather reduces larvae on herbage. Plan grazing to keep young stock off the most contaminated areas of pasture during periods of rapid larval build-up if possible.

Forages other than permanent pasture can reduce parasite challenge to susceptible animals and provide them with improved nutrition, while helping to reduce contamination of permanent pasture.

By and large, cattle, sheep and deer do not share the same worm species.

Planned integration of different livestock species or classes can reduce the overall worm challenge to each species, when done well.

Healthy, well fed adult animals can be net removers of larvae from pasture.

At times, adult animals of the same species can be used to reduce the number of infective larvae on pastures.

Genetics - animals can be selectively bred for resistance or resilience to worms.

Animals can be bred to have a higher resistance to the establishment of worms, or to be more resilient to the effects of worms. Increased emphasis on these traits will result in faster genetic progress being made. In modern sheep breeding, index selection provides sires which perform well in maternal traits, as well as conferring improved parasite resistance or resilience to their progeny.

Genetic changes are permanent and cumulative. Over time, the result will be a lower need for drench inputs. Work in New Zealand selecting cattle for better ability to cope with worms is in its early stages.

Refugia

Think Wormwise, think
F.A.**R**.M.ED

Don't let the drench survivors dominate.

Refugia refers to the portion of a parasite population that is not exposed (i.e. in refuge) to drench treatment. This untreated pool preserves susceptible genes and dilutes those from resistant survivors, slowing the development of drench resistance in the worm population.

The amount of refugia that is required depends on drench efficacy. If the drench used is letting a lot of worms survive, more refugia is required to dilute out the resistant worms. Monitoring drench efficacy is critical.

Monitoring

Think Wormwise, think
F.A.R.**M**.ED

Effective monitoring is critical to measure the success of worm management strategies.

Monitoring the impact that worms are having on stock can be via a combination of tools including specific diagnostic tests for worms, weighing and body condition assessment, monitoring of feeding and grazing history as well as observation of stock.

Monitoring drench performance should never be done 'by eye'. Faecal egg counts are a critical first tool for measuring the efficacy of drenches.

Effective **D**renching

Think Wormwise, think
F.A.R.M.**ED**

Using ineffective drenches undermines parasite control efforts.

Regular use of ineffective drenches promotes resistance, harms animal health and productivity and increases economic costs.

Regular monitoring should be used to constantly check drench performance, and to ensure that effective drenches are used in a sustainable way.

Each anthelmintic is a finite resource, every time drench is used there is selection pressure for resistance. In particular, the use of long-acting drenches may hasten the development of drench resistance.

We cannot rely on the continual development of new anthelmintics.

Chapter 1: Effects of worms and how they limit production

Larval challenge occurs whenever animals eat pasture contaminated with infective L3 larvae. All animals grazing pasture in New Zealand will be exposed to some level of larval challenge. Regular drenching does not eliminate the effects of larval challenge.

Worm infection can cause appetite suppression and altered grazing behaviour, as well as demanding an immune response, which is a cost to production. Production loss due to worms is of greatest importance in young stock.

Young stock are also the main multipliers of worm populations and can become a major source of pasture contamination.

Physical signs of worms represent the end stage of a complex and progressive disease process. Their appearance represents failure of your worm management strategies.

Introduction

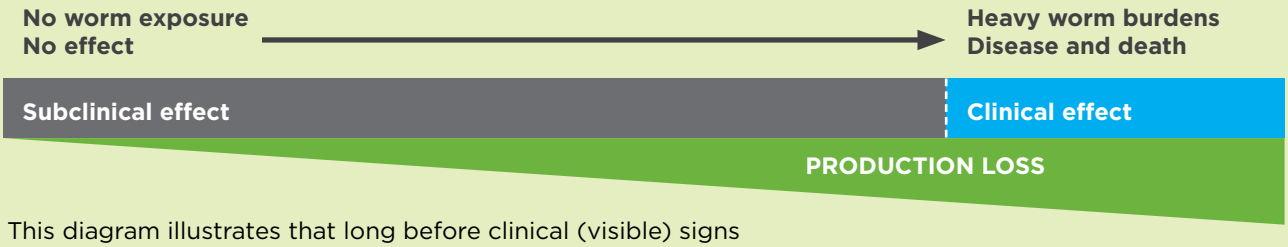
As livestock farmers know, worms are one of the main threats to stock health and production. After reading this chapter you will understand the ways in which worms exert their effects on animals and how this affects different stock classes throughout the year. You will also appreciate how this understanding can assist in your farm management.

Two popular concepts of how worms affect livestock are:
- That they compete for nutrition with the animals they infect, and
- That they cause damage to the gut leading to inefficient feed utilisation and scouring.

Both of these are true, although for the most part even large numbers of worms do not "rob" animals of nutrition. The exceptions to this are the blood sucking parasites such as *Haemonchus* (Barber's pole worm).

The impact of worms on animal production begins as soon as animals ingest worm larvae from pasture. These effects may be viewed as a continuum from no exposure to worms, and therefore no impact, to the presence of heavy burdens of worms in animals leading to disease and even death.

The point at which these effects become visible, either through liveweight or body condition loss, or through physical symptoms such as scouring, is called clinical parasitism. Before this, the unseen but important effects, from a productivity point of view, are called subclinical parasitism.



This diagram illustrates that long before clinical (visible) signs of worm infection occurs, there can be significant production loss.

Subclinical effects of worms

It is safe to say all grazing animals in New Zealand will be exposed to worms on pasture, The level of impact will depend on the amount of pasture contamination, and the age and immune status of the animal.

The process begins with animals picking up infective L3 worm larvae when grazing contaminated pasture. This daily intake of worm larvae and subsequent buildup of worms in the gut is known as larval challenge.

These larvae are foreign to the animal in a similar way to bacteria or viruses. There are two major effects of regular larval intake:

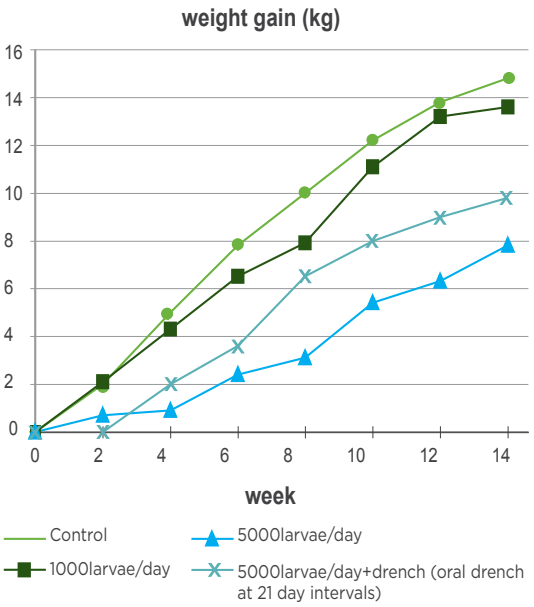
1. Appetite suppression and changed grazing behaviour. This can occur in some animals even at quite low levels of larval challenge, resulting in reduced feed intake.
2. The generation of an immune response to the incoming larvae. The immune response requires energy and protein. Both of these are diverted away from production. This can manifest as reduced growth, weight loss, reduced wool growth and reduced milk production.

There are numerous studies that demonstrate these effects. Two are summarised below: One in lambs and the other a series of trials in cattle.

Effect of daily larval intake on growth of young lambs:

The graph below shows the growth rates of previously worm-free lambs dosed with different levels of infective L3 (larval challenge). The control animals received no larvae. The animals were housed and fed a dry ration. Growth rates and feed intake were monitored.

Effect of daily intake of *Ostertagia* larvae and drench on growth of young lambs (adapted from Coop *et al* 1982)



It can be seen that the reduction in growth rate as a consequence of L3 challenge occurs immediately. The growth suppression increased with increasing challenge.

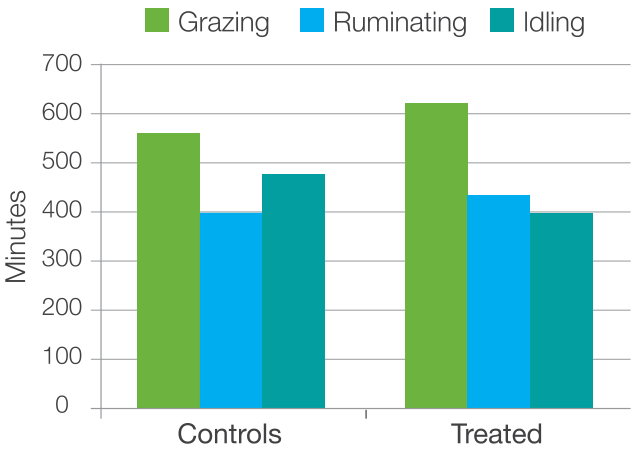
The depression of feed intake of both drenched and undrenched groups receiving 5,000 larvae per day was the same. At slaughter, the drenched group had no resident worms, from which we can deduce that establishing worms were removed at each drench. None of the animals in this trial showed clinical signs of parasitism.

This trial demonstrates the subclinical effects of larval challenge. Regular drenching to remove established worms only allowed the lambs to achieve around half of the liveweight gain that would have been possible on worm-free feed. In other words, drench on its own cannot eliminate the effects of worms.

Impact of larval intake on grazing behaviour of cattle:

Past work has looked at the effects of grazing behaviour in both young and adult cattle using sensors attached to the animals' jaws. Animals were either treated with long-acting drenches, both to remove resident worms and negate the effects of larval challenge, or allowed to become naturally infected by grazing contaminated pasture. Observations were made over a 28-day period. The trials showed exposure to worms reduced productive grazing behaviour. Consequently, there were reductions in weight gain in young cattle and in milk production in adult dairy cows.

The graph shows the differences in behaviour between two groups of adult cows in one of these trials.



Adapted from Forbes *et al* Vet. Parasitol 2004

Cows exposed to worms spent less time grazing and ruminating and more time in non-productive behaviour (idling). It should be noted in the above study on dairy cows that the study animals were run in pairs in the same paddocks for the duration of the study (New Zealand dairy cows will typically get fresh grass every day). Wormwise recommends nutrition and grazing management strategies over the use of long acting drenches to improve feed intake.

None of the animals in either of these trials showed clinical signs at any stage. The trials demonstrate the subclinical effects of worm exposure and their impact on productivity. It appears that the suppression in appetite is involved in the immune response to challenge.

Other trials involving animals whose immune system has been artificially suppressed have found nil or minimal effects in terms of on productivity when these animals are challenged with worm larvae. This highlights the importance of the animals' own response in losses we see with worms.

Clinical disease caused by worms

The clinical effects of worms on animals are a progression from the subclinical effects, as worms become established in the body.

The distinction between clinical and subclinical is an arbitrary one and may depend on how hard you are looking. Generally speaking, at the clinical stage there are visible signs in the animal. The major physical signs are weight loss, scouring and dehydration.

Worms cause varying amounts of direct damage to host tissues by their activities of feeding on the gut lining or sucking blood. Most effects in the subclinical stage are due to the host reaction to the presence of worms and lead to the clinical signs of disease that we can see.

Worm larvae can invade the glands of the gut lining. In some species the adult worms burrow into the lining, though many simply reside in the surface mucous layer. The inflammation resulting from their presence can sometimes lead to secondary bacterial infection and ulcers.

The animal's defensive inflammatory response causes changes in the structure and physiology of the gut, leading to disturbances in normal gut function. The gut lining may thicken or nodules may form. Abnormal acid or hormone production may occur and the gut becomes "leaky", possibly resulting in loss of fluid and protein. Feed conversion efficiency suffers resulting in weight loss, and diarrhoea (scouring) may occur. If these changes are sufficiently severe, death can result. In the case of Haemonchus, death is the result of blood loss.

At the point where the physical symptoms of worm infection, such as weight loss and diarrhoea are apparent, the end stage of a complex and progressive disease process has occurred. It could be said that the appearance of these signs represents failure of your worm management strategies.

Age effects and immunity

Worms in young animals

Young animals first encounter worm larvae when they start grazing and at this point they have no specific immunity to them. Lambs and calves in their early weeks of life are considered ‘pre-ruminants’ (their rumen has yet to develop the ability to digest grass), at this stage of their life they generally do not attempt to mount an immune response to incoming worm larvae, with their growth performance relatively unaffected by the larvae they are ingesting.

As they get older, lambs and calves’ immune systems begin reacting to worms – to begin with this response is inefficient and can result in substantial amounts of protein and energy being lost that would otherwise have gone towards growth, while the worms are relatively free to continue developing and reproducing.

The result is that young stock are a fertile breeding ground for the multiplication of worm populations and can become a major source of pasture contamination.

Because young animals require large amounts of energy and protein to grow, they are highly susceptible to the effects of parasites. Production loss due to worms is therefore of greatest importance in young stock.

A successful worm management programme should aim to minimise exposure of young stock to worms. Poor feed quality and slow growth of young stock are enemies to their developing worm immunity. The immune system is energy and protein hungry and depressed by the physiological response to stress, so very good nutrition and minimising stress are important management considerations.

Worms in adult animals

Both cattle and sheep generally develop ‘full’ immunity to worms by 18–20 months of age, though rising 2 year old cattle and 2 tooth ewes can still be more susceptible to worm challenge than older animals.

Healthy adult animals generally cope much better with worm challenge as their immunity is fully developed and they are not growing, but the comments above regarding nutrition and stress still apply. Maintenance of the immune response to worms requires both energy and protein. Where these are insufficient in the diet, worm immunity can be compromised.

Ewes and cows can show some relaxation of worm immunity near the end of pregnancy, with clinical effects being more likely if they are underfed. In ewes this can also lead to higher faecal egg outputs as the decreased immunity allows worms to reproduce more freely.

Ewes and cows in lactation have a high energy and protein demand, so the effects of worm challenge can have a higher impact on productivity. Your worm management strategy should aim to minimise exposure of these animals to worm challenge from pasture.

In ewes, providing extra protein in the diet has been shown to reduce this drop in worm immunity in late pregnancy.

Continual exposure to at least a low level of worms is thought to be important for the maintenance of good immunity, and it is extremely likely there are sufficient worm numbers on New Zealand pasture for animals to develop and maintain such immunity.

Rams and bulls at mating time are another example of when attention to these principles is important.

Conclusion

This chapter explains that the subclinical effects of worms can have a major impact on profitability. By giving some thought to when each stock class is likely to suffer productivity losses from worm challenge, these losses can be minimised.

Successful worm management strategies should aim to minimise exposure at these critical points in your farming operation. The rest of this book provides the information required to develop these strategies and put them into action.

Remember the whole area of worm management is extremely complex and unexpected things can happen. Forming a partnership with an animal health adviser who understands this area well, will greatly increase your chances of success.

Bibliography

B+LNZ Factsheet 151: Worms in refugia

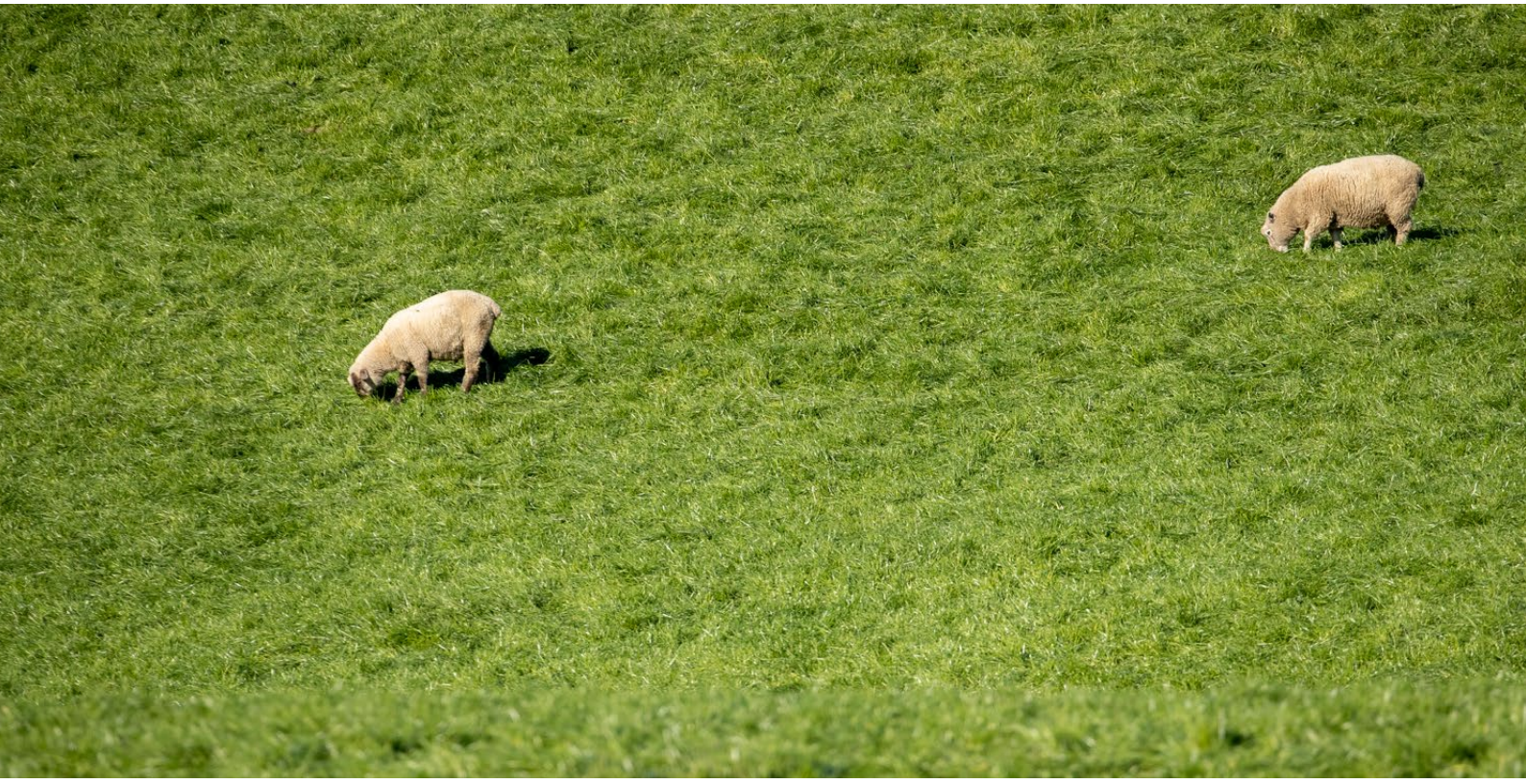
B+LNZ Podcast with Dave Leathwick, AgResearch, on internal parasites and drenching: https://beeflambnz.podbean.com/e/ dave-leathwick-animal-health-internal-parasites/

Sustainable control of internal parasites in ruminants. Animal industries workshop 1997 G K Barrell, Lincoln University Press

The Sheep: Health, Disease and Production. 4th Edition 2018. DM WEST, AN BRUÈRE AND AL RIDLER. Massey University Press, Palmerston North

Coop R L et al. 1982. The effects of three levels of intake of *Ostertagia circumcinta* larvae on growth rate, food intake and body composition of growing lambs. Journal of Agricultural Science (Cambridge), 98, 255

Forbes et al. 2004. Impact of eprinomectin on grazing behaviour and performance in dairy cattle with subclinical gastrointestinal nematode infections under continuous stocking management. Veterinary Parasitology 125, 364



Chapter 2: Worm biology

Sheep and cattle in New Zealand are infected by a variety of different worm types.

Worm eggs pass out of animals in their dung. The eggs hatch into larvae that develop in the dung pat to become infective (L3).

L3 move out of the dung onto pasture where they can be eaten by grazing animals.

The number of larvae on pasture is affected by weather. Warm moist conditions allow greater numbers of eggs developing to infective larvae. This can take as little as 7-10 days under ideal conditions.

It takes around 21-28 days from when an animal eats a worm larva to when worm eggs appear in dung. The whole life cycle may be completed in four weeks; even less in special cases.

The number of eggs and larvae present on pasture is much higher than the number of worms inside animals. Therefore, effective worm management requires more than simply killing worms in the animal. It should minimise exposure of susceptible animals to worms at crucial times.

Most larvae are found in the first 2cm of pasture height or in the first 1cm of soil. Grazing to low residuals exposes animals to a higher level of larval intake compared to animals lightly grazing the same pasture.

Introduction

Several different types of worms live inside sheep and cattle. This handbook focuses on roundworms (also called nematodes) that live in the gut and are referred to as "worms". Flukes and tapeworms are commonly found and are also discussed briefly.

The worms of most importance in New Zealand livestock live in the animal's gut (stomach and intestine). Although this book refers to worms as if they are all the same, there are actually several different types. These may vary in size, where they live in the animal, and in their impact on stock.

Individual worm species that infect cattle do not usually infect sheep and vice versa, even though they might have the same genus name. Some worms live only in the stomach (abomasum), others only in the small intestine, and *Trichostrongylus* species can be found in both.

The correct name for what we have traditionally called *Ostertagia* in sheep is now *Teladorsagia* and we will use this name in the handbook.

The worm families/types listed are those that cause the most problems in sheep and cattle. There are others that are less commonly detected or rarely a primary cause of disease: Examples are *Bunostomum* (hookworm) *Strongyloides* (threadworm) and Trichuris.




Although worms are often referred to by their scientific name, some also have common names. For example, *Haemonchus* is also called Barber's Pole worm.

Lungworm is another type of roundworm that lives in the lungs. Outbreaks of lungworm can be a problem in young cattle.

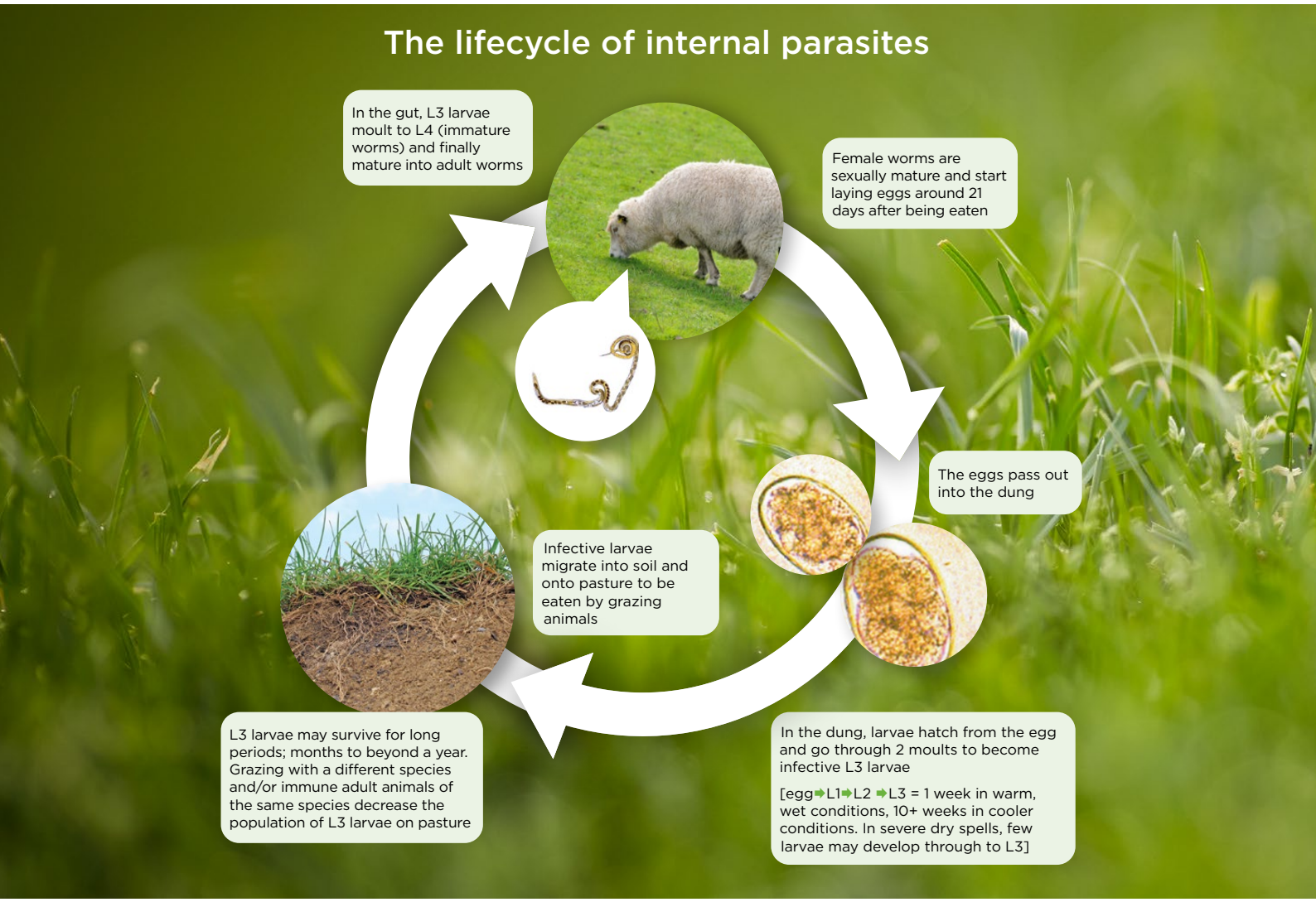
Important worm types

	Sheep	Cattle
Stomach	*Haemonchus contortus* *Teladorsagia circumcincta* *Trichostrongylus axei*	*Ostertagia osteragi* *Trichostrongylus axei*
Small intestine	*Trichostrongylus colubriformis* *Trichostrongylus vitrinus* *Nematodirus filicolllis* *Nematodirus spathiger* *Cooperia spp*	*Cooperia oncophora* *Trichostrongylus vitrinus* *Trichostrongylus colubriformis* *Cooperia puncata*
Large intestine	*Oesophagostomum, Chabertia*	

Geographic variations

Most of the worms listed occur and cause problems in all areas of New Zealand. However, *Haemonchus* is more of a problem in the warmer areas of the North Island and upper South Island because it requires a higher temperature range for development.

Nematodirus fillicolis causes more problems in the colder south as it is adapted to cool, short summers and its larvae survive cold winters on pasture. *Ostertagia* (cattle) *Teladorsagia* (sheep) and *Trichostrongylus* occur in all areas.



The life cycle of roundworms

The common roundworm of sheep and cattle has three phases in its life cycle: egg, larva and adult. The adult stage is the worm that lives in the gut of the animal; some species can be seen on close inspection when the stomach (abomasum), small intestine or lungs are cut open.

Adult female worms lay eggs, which pass out of the animal in the dung. The immature worm hatches out from an egg within the dung pat. At hatching it is called a larva and in most worm species will go through four larval stages. The first three stages of development take place within the dung pat; the first two stages (L1 and L2) feed on material in the dung pat.

The third larval stage (often referred to as L3) is the infective stage. L3 larvae migrate out of the dung onto the grass, where they can be eaten by a grazing animal. A small proportion of L3 larvae can exist in the top 1-2cm of soil.

Under ideal environmental conditions, development from egg to L3 takes around seven days, but can be as long as five to ten weeks depending on warmth and moisture. Heavy dew and rain release the L3 from the dung onto the pasture.

Rate of movement of L3 in moisture films and droplets in the sward is driven by warmth. In warm conditions, where there is also plenty of moisture in the pasture, L3 can be found further up the sward and hence more likely to be consumed by grazing animals. Larvae protected in soil and dung during dry spells can move rapidly once moisture arrives and be found on previously dry pasture within 24 hours.

When the L3 are eaten by an animal they undergo another moult to become an immature worm (L4 larva), which moults once more and matures into an adult worm. Adult worms mate inside the host animal; female worms produce eggs. The time from ingestion to production of eggs is about 21 days. The eggs pass out in the dung and the life cycle begins again.

Nematodirus has a slightly different life cycle from the other common worms. The larvae develop inside the egg in the dung pat and it is the infective third stage larva that hatches from the egg. Because the larvae are protected inside the egg, they can survive over winter to hatch in the warmer spring or summer weather. From then on they behave like other types of roundworm.

Eggs of *Haemonchus* (Barber's Pole) are different from other worm eggs in that they require a relatively high temperature to complete their development. This is why *Haemonchus* is more of a problem in the warmer parts of the country.

Survival of eggs and larvae

The development of worms from an egg through the larval stages requires a moist environment and occurs at a different rate at different temperatures. At low temperatures development is slow, whereas in warmer temperatures it is faster. A temperature of 20-25°C is optimal for larvae, as they die at higher temperatures due to desiccation (loss of moisture or dehydration).

Many developing eggs and larvae are killed by hot, dry weather, and most eggs on pasture die during cold weather (average air temperature less than 10°C). Some larvae survive through winter, also known as "overwintering", and together with new eggs shed by animals in early spring, this initiates the new season build-up in worm numbers.

Infective larvae (L3) are relatively hardy. Once the larva has reached the infective third stage (L3), temperature and moisture will determine how long it survives.

L3 larvae on pasture eventually die as they cannot feed and have to survive on stored energy. In cooler temperatures some larvae may survive for up to eight months and in some cases for more than a year. In warmer temperatures larvae may survive only two or three months. Naturally, the longer pasture is left or spelled without grazing animals, the fewer infective larvae it will contain. The length of time this takes will vary, as it depends on climatic factors.

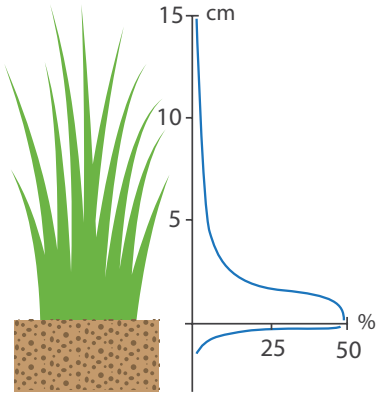
The type of pasture can also affect the rate at which dung pats dry out and eggs and larvae die. Some open sward pasture species provide a less suitable environment for larval survival than those with a dense thatch.

Most larvae are found in the lower third of pasture height or in the first 1cm of soil. When animals graze pasture with longer grass they are likely to be taking in fewer worm larvae than when they graze pasture with shorter cover.

Grazing to low residuals exposes animals to a higher level of larval intake than animals lightly grazing the same pasture. Amounts and patterns of dung deposition, and therefore numbers and distribution of parasites on pasture, will vary with the type of grazing management.

The relative concentration of larvae per kg of drymatter in a pasture sward has been found to not be substantially different between the bottom, middle and upper thirds of the sward. However, there is much more drymatter in the lower third of the sward, hence more larvae at this level.

The vertical distribution of infective larvae on grass.



Inhibited larvae

At some points in a worm's life cycle, development can become arrested or inhibited. Development resumes later, presumably after a favourable stimulus has been received. The most obvious example of this is the infective third larval stage. This stage will not advance to the next (L4) and it does not grow, or even feed, unless it is eaten by a suitable host animal.

Another example of arrest occurs in the parasitic phase of the life cycle. Recently acquired larval stages may become temporarily inhibited during development inside the host. This kind of arrest commonly affects the L4 stage. Not all larvae may undergo arrest and the length of time they spend in this state varies.

Environmental factors are thought to play some role in encouraging larvae to become arrested. Exposure of the infective L3 to cooling pasture temperatures in the autumn is thought to encourage them to become arrested once they have entered the host. They typically resume development after a few months, towards spring, when their progeny will find conditions outside the animal more favourable for development. Arrested development also tends to occur in areas with regular dry seasons.

Host factors, principally the immune status of the host, may also encourage arrest, whilst exposure of animals to stress (and concurrent reduction in immune capability) may contribute to larvae 'waking up' and recommencing development.

In most cases, the resumption of larval development has no real consequences for the host animal. One exception to this is seen in cattle, in which the synchronous resumption of development of previously inhibited *Ostertagia ostertagi* larvae can cause a lot of damage to gut tissues, resulting in the syndrome called Type II ostertagiosis (see page 17). This syndrome is uncommon in New Zealand. Here, Ostertagia larvae mostly development sequentially rather than en masse, and clinical signs of Ostertagiasis are generally caused by high challenge.

The prepatent period

Typically, it takes around 21 days from when a lamb or calf ingests a worm larva to when worm eggs appear in dung samples. In some worm species, it takes slightly longer. This is called the prepatent period.

It is important for two reasons:

- The commonly recommended minimum interval of 28 days between drenches in young stock is aimed at limiting pasture contamination with worm eggs, while allowing the establishment of some worms that are not drench survivors, to aid in refugia. This approach must be combined with other means of both providing refugia and limiting pasture contamination. See chapters 4. Avoiding the worms and 5. Refugia.
- Worm egg counts provide, at best, a 'picture' of the levels of larval challenge on pasture, three weeks or more prior to measurement. You may therefore think animals are free from worms but, under the right conditions, they could have picked up a considerable burden. Obviously, if a drench with persistent activity was used, the period from drench to eggs appearing in the dung is longer (the length of action plus the 21-day prepatent period).

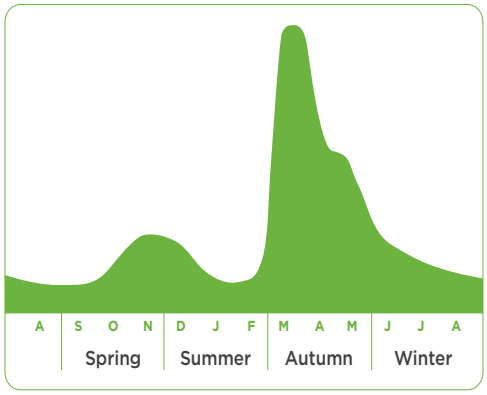
Seasonal patterns of larvae on pasture

Larval numbers on pasture are generally highest in late spring and autumn. This is because worms complete their life cycle fastest in warm, wet conditions. Many developing eggs and larvae are killed by hot, dry summer weather and fewer eggs develop in the colder temperatures of the winter months. The mild, moist conditions of spring and early summer are ideal for larvae, so their numbers on pasture increase. Numbers build up through summer and early autumn but drop off if hot, dry weather occurs.

Danger periods extend from spring to early winter; extreme danger occurs from March to July. This will vary across the country according to the climatic conditions. The number of eggs and larvae present on pasture is much higher than the number of worms inside animals.

Generally, when conditions are favourable, 85–95% of the worm population will be found in the soil or on pasture and the remaining 15% are elsewhere (animals, faecal pats). It is very important to remember this when planning worm management. Simply killing worms in the animal is only a part of the overall strategy to minimise exposure of susceptible animals to worms.

Generalised seasonal pattern of the amount of infective larvae on the pasture arising from untreated sheep.



Seasonal pattern of worms in sheep

The seasonal pattern of worm burdens in sheep reflects the levels of pasture larvae they are eating. The number of worm eggs in faeces is measured by faecal egg counts. In areas mainly grazed by young sheep these typically reach a peak in autumn.

Numbers of larvae on pasture are related to the numbers of eggs passed out by the grazing animals. In general, young, infected animals will pass much larger numbers of eggs than older animals. As animals mature, they develop immunity to worms, so carry fewer numbers and pass fewer eggs onto the pasture.

However, during late pregnancy and in early lactation, ewes can experience a temporary drop in immunity and consequently pass more worm eggs in their faeces. This is known as the 'periparturient rise' in egg counts (PPR), which may begin prior to lambing and often peaks around mid-lactation.

By the time of weaning, the ewe's immune response should have recovered, and egg counts returned to normal. This rise in egg counts does not occur in all ewes every year. It will generally be greater for ewes with multiple lambs and young ewes having their first lamb. Ewes from a worm-resistant genetic background have been shown to have a lower or absent PPR.

The level of worm challenge faced by young lambs in spring is derived from overwintered larvae from the previous autumn, with a variable contribution from the PPR.

Different types of worms have different seasonal patterns of prevalence in sheep. The most common worm in ewes during the PPR was traditionally understood to be *Teladorsagia* but recent work has highlighted that *Haemonchus* plays a bigger role in ewe infections throughout the year than it did several decades ago, including over the PPR.

Survey work from 9 New Zealand farms (4500+ faecal samples) in 2022 indicated that eggs from *Cooperia* were most predominant in both ewes and lambs year-round. This was followed by *Haemonchus* which showed peaks in young sheep in the summer months and ewes over the PPR.

Trichostrongylus colubriformis was predominant in lambs in late autumn and winter. Ewes produced far less eggs of this parasite than did lambs.

Seasonal pattern of worms in cattle

The seasonal pattern in cattle is similar to that of sheep. However, the main peak is late autumn/early winter.

Calves born in spring become infected as soon as they start nibbling pasture. Larvae on the pasture at this time of year have survived over winter. These mature inside the calf and produce eggs which contaminate the pasture in spring and early summer. Therefore, by early summer larval numbers on pasture have built up and calves become re-infected, resulting in an even heavier burden. The eggs from these worms cause a peak of larvae on pasture in May/June.

As calves mature they start to develop some resistance to worms and faecal egg counts start to fall. With the lower egg counts and cooler weather, the larval numbers on pasture begin to drop through the second half of winter. The growth of grass in spring means the larvae are spread over more pasture and are thus diluted.

Calves have their greatest burden of *Ostertagia* and *Cooperia* in their first winter. By the time they are a year old they have normally developed resistance to *Cooperia* and to some level, *Ostertagia*. However, peak numbers of *Trichostrongylus axei* (both as larvae on pasture and worms in the abomasum) occur later, in about October, and drop off soon after. So it is not until cattle are about 18-20 months of age that they have significant levels of resistance to all three major species.

Calves in their first year are the main source of pasture contamination. Climatic variations in different parts of the country have some effect on the patterns. Larval development on pasture is more rapid and continues for longer throughout the year in warmer areas.

Important worm types

Haemonchus contortus

- Primarily a parasite of sheep and goats, can establish in small numbers in cattle and deer
- Called Barber's Pole worm because of its appearance
- Blood-sucking
- Lives in abomasum (4th stomach)
- Quite large (20–30mm)
- Female Barber's Pole worms are prodigious egg layers and can lay up to 10,000 eggs per day
- The danger period for *Haemonchus* is in late summer and autumn. The numbers of *Haemonchus* can build up rapidly, leading to sudden and severe illness in lambs. Being a blood-sucking worm, it can cause lamb deaths from anaemia and blood loss. It can affect two tooth ewes, but less commonly causes serious illness in older sheep.

Teladorsagia circumcincta

- Internal parasite of sheep called brown stomach worms
- Female worm lays 50–100 eggs per day
- Lives in abomasum (4th stomach) and can cause substantial damage as they invade the glands in the lining of the organ.
- Quite small (~10mm)
- The L3 larvae of *Ostertagia* are resilient and able to survive freezing on the pasture and dry conditions.

Ostertagia ostertagi

- *Ostertagia* is the most pathogenic worm for New Zealand cattle. *Ostertagia* larvae can embed themselves in the wall of the abomasum in small nodules and remain dormant there for several months without maturing. When ready, they emerge from the wall of the abomasum as adult worms and lay eggs.
- The disease ostertagiasis causes can occur in two forms: Type I and Type II.
- Type I ostertagiasis is the typical scouring and weight loss associated with other worm infestations in calves. The larvae mature normally and the effect of them and adult worms in the stomach causes loss of appetite, poor feed conversion and weight loss. Type I ostertagiasis is of most importance in summer and autumn.
- Type II ostertagiasis results when the inhibited larvae in the stomach wall mature and break out of the mucosa, causing damage to the stomach lining. In some situations large numbers emerge at the same time and can cause sudden and severe illness, and even sudden death. This mass emergence usually occurs in the spring in animals of 9–12 months or older. Their presence will not be detected by faecal egg counts (FEC) because it is the maturing larvae that cause the damage, not the adult worms. Type II disease is relatively rare in New Zealand.

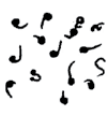
Trichostrongylus

- There are three common species of *Trichostrongylus*. Adult *Trichostrongylus axei* worms (also called stomach hair worm) live in the abomasum of sheep and cattle (and other species such as horses and pigs). *Trichostrongylus axei* is generally a minor component of both sheep and cattle infections, and the fact that it is shared by both hosts appears to have little practical impact for managing cross-species grazing.
- *Trichostrongylus colubriformis* (black scour worm) and *T. vitrinus* live in the small intestine of sheep; both cause damage to the lining of the gut. *T. colubriformis* can build to very high numbers in lambs in autumn.
- Adult female worms lay 100–200 eggs per day.
- *T. longispicularis* is a fairly minor parasite of the small intestine of cattle. The effects of *Trichostrongylus* in cattle are intermediate between *Ostertagia* and *Cooperia*. However, *Trichostrongylus* worms can be very damaging in sheep. The main danger period for *Trichostrongylus* is in late autumn and winter. The infective larvae are very resistant to cold and their numbers can reach high levels in the cooler months.

Haemonchus

Ostertagia

Trichostrongylus



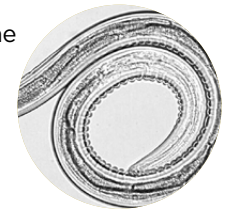
Cooperia

Nematodirus

Nematodirus

- Internal parasite of sheep
- *Nematodirus filicollis* is called the thin-necked intestinal worm. The female worm lays 25–30 eggs per day in the small intestine. These pass out into the dung.
- The larvae develop to 3rd stage (L3) in the egg shell over a period of two or more months. The combination of egg shell and L3 sheath make it able to survive desiccation and cold, and it survives winter in large numbers. This overwintering means the pattern of infection for *Nematodirus* can differ from other worms, in that transmission can occur directly (via pasture) from one season's lambs to the next. Sudden outbreaks of clinical disease can occur in lambs before weaning. This is more common in the southernmost parts of New Zealand.
- *N. spathiger* can be present as a generally minor component of the worm burden in sheep throughout the country and rarely cause disease on their own.

Cooperia

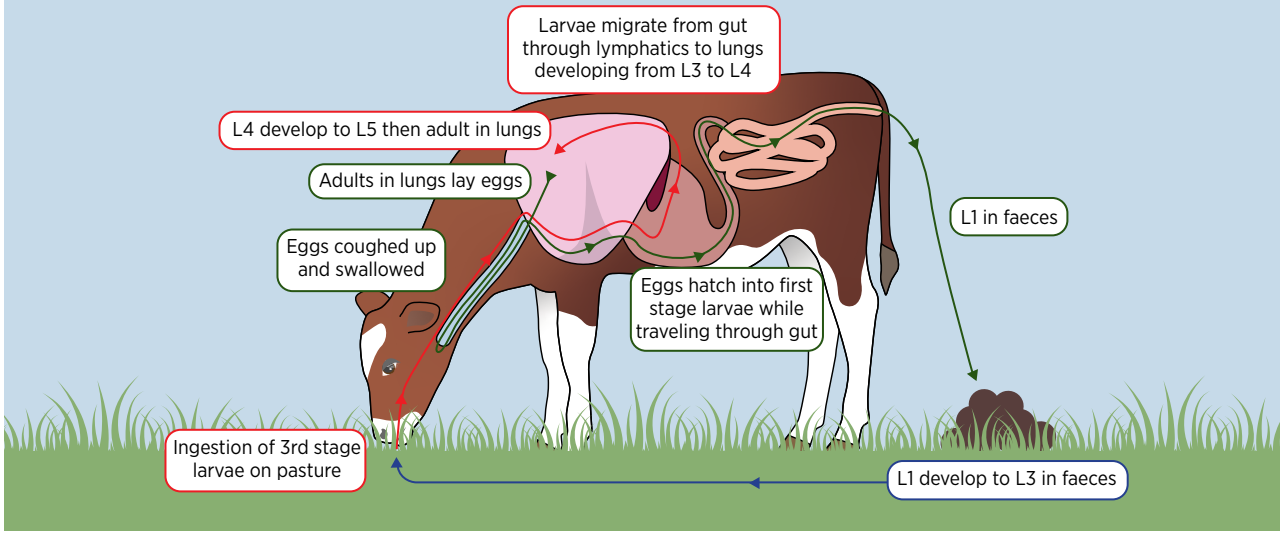


- Called small intestinal worm
- Small intestinal worm 10–15mm long and found coiled close to the wall of the small intestine
- *Cooperia* is most common in autumn but is rarely important
- In cattle the parasitic effects of *Cooperia* are significantly less than those of *Ostertagia* but as they can lay large numbers of eggs large populations can develop, making *Cooperia* a significant worm problem in intensive cattle farming systems.
- *Cooperia* is considered to be one of the less damaging gut worms of sheep.

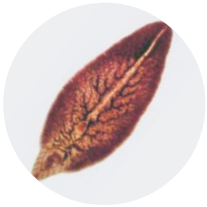
Lungworm

- The common species of lungworm in New Zealand are *Dictyocaulus vivaparus* in cattle and *Muelleris cappilaris* in sheep. The latter is generally an incidental finding and not thought to be a primary cause of disease. Deer have their own species of lungworm.
- *Dictyocaulus viviparus* can cause sudden and severe disease in calves in their first year of life and occasionally in older cattle. Immature worms and adults live in the airways of the lungs; when present in high enough numbers they cause irritation and inflammation. Animals severely affected with lungworm may cough and have difficulty breathing. They often have a mucus discharge from the nose.
- Adult lungworm lay eggs in the airways which are coughed up and swallowed. These hatch into L1 larvae while travelling through the digestive system. L1 larvae are passed in the faeces. Development through to L3 is quite rapid and can happen in 4-5 days. Lungworm L3 don't move far from dung pats on their own but can be 'fired' onto pasture with spores of the *Pilobus* fungus which grows on cattle faeces. Larvae congregate on the reproductive capsule of the fungus and are propelled away from the dung pat when it explodes to release it's spores.
- When eaten by grazing cattle, L3 larvae move to the small intestine, moving across the intestinal wall to the lymphatic system. They moult to the L4 stage while travelling through the lymphatic system to the lungs.
- The time from ingestion of an L3 larva to new adults producing L1 larvae in the faeces is about 4 weeks. However, L4 larvae and immature adult worms can cause disease before larvae are evident in the faeces. This, combined with the sometimes very rapid development of the larval stages in the environment, can cause sudden and unanticipated outbreaks of disease.

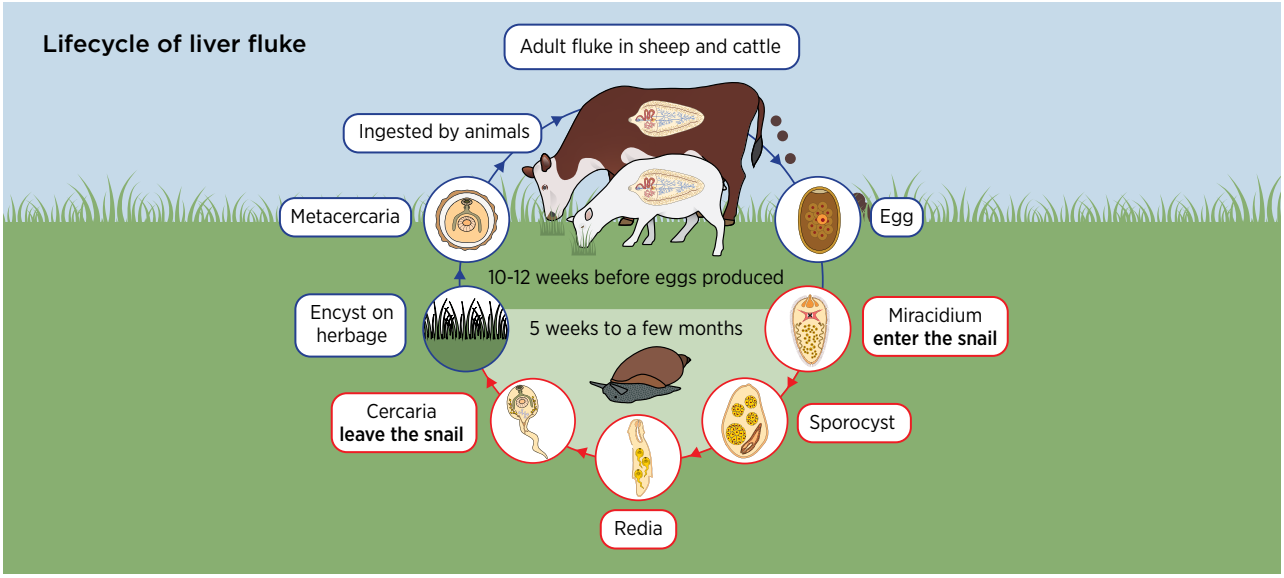
Schematic diagram of the lifecycle of lungworm in cattle. The rumen has been removed in this diagram.



Liver Fluke



- The life cycle of liver fluke involves an intermediate host, the mud snail *Psuedosuccinia (Lymnaea) columella* and several free-living stages.
- The snail prefers slow-flowing freshwater environments, including streams, swamps and ponds. It is prominent in the northern North Island but also present in the South Island. The species thrives in areas that may experience summer drying, as it can survive by burrowing into mud.
- Adult fluke lay eggs that are passed out onto pasture in the dung. At suitable temperatures, a miracidium develops within the egg, hatches and migrates in moisture on the pasture, seeking the snail host. Miracidia can only survive for a few hours outside the snail. Within the snail they go through several development stages to become infective cercariae. Within the snail these life stages multiply many times. Cercariae emerge from the snail when the temperature and moisture levels are suitable.



- The cercariae migrate onto wet pasture and form a cyst called a metacercariae. It is this stage that is eaten while animals are grazing the wet pasture close to waterways. The time taken to reach this stage on pasture is highly variable but may be 8-10 weeks under suitable conditions.
- Within the animal, immature flukes migrate to the liver, through which they tunnel, feeding on blood and tissue. The immature flukes become egg-laying 10–12 weeks after the metacercariae are ingested. The whole cycle may take 18-20 weeks.
- The hatching of fluke eggs and the multiplication of snails depend on adequate moisture and temperatures greater than 10°C.

Tapeworm

- The tapeworm (*Monieza expansa*) is the largest internal parasite of sheep in New Zealand. Tapeworms are common in young lambs, and the tapeworm segments can often be seen in their faeces. By about eight months of age animals usually spontaneously lose their tapeworm burden.
- The tapeworm segments passed in the faeces contain eggs, which develop inside a small pasture mite. The animal becomes infected when it eats the mite on the pasture it is grazing.
- There is little evidence that tapeworms have a significant detrimental effect on lamb growth rate. Tapeworms are rare in cattle and little is known about their effects.

Bibliography

Sustainable control of internal parasites in ruminants. Animal industries workshop 1997 G K Barrell, Lincoln University Press

The Sheep: Health, Disease and Production. 4th Edition 2018. DM WEST, AN BRUÈRE AND AL RIDLER. Massey University Press , Palmerston North https://masseypress.ac.nz/products/the-sheep

The seasonality of gastrointestinal nematode species abundance (excluding Nematodirus) in sheep of different classes across New Zealand. Waghorn T, Chambers A, Bouchet C, Hannaford R, Jones M, Miller C, Sauermann C & Leathwick D. New Zealand Journal of Agricultural Research June 2025.

Chapter 3: Feeding

Think Wormwise, think
F.A.R.M.ED

Good nutrition greatly enhances animals' ability to deal with worms.

Well-fed animals are less affected by worms than those under nutritional stress.

Growing out young stock quickly reduces the length of time that they are susceptible to worms and can reduce the amount of drench needed in a farm system.

Feeding stock well

Good nutrition is paramount for parasite management on farm. It not only enables adult animals to cope with worms more effectively but enables young animals to grow as quickly as possible to a stage of maturity where they develop some of their own immunity to worms.

Growing out young stock quickly reduces the length of time that they are net contaminators of pasture with worm larvae and can reduce the amount of drench needed in a farm system. Young stock will also contribute less to the worm population on pasture, resulting in less contamination for all stock.

Feed planning

Setting feeding targets, including average pasture cover targets for key times of the year, and understanding the balance between daily feed demand and pasture growth is very important for worm management.

Some ideal grazing residuals for good stock performance are detailed below. When grazing lower than these targets, not only can stock performance suffer for nutritional reasons, but the impacts of worm larval intake are greater. As previously mentioned in Chapter 2 there are more parasite larvae near the bottom of the sward, so if this is where stock are spending a majority of time grazing, it is more likely that they will suffer the negative impacts of worms and require more frequent drenching.

A full discussion on feed planning is outside the scope of this document, but a great set of resources can be found at: www.beeflambnz.com/knowledge-hub/feed-planning

Feed levels referred to below are aligned with grass measurements undertaken with a B+LNZ Sward Stick www.beeflambnz.com/sites/default/files/factsheets/pdfs/fact-sheet-92-measuring-pasture-covers-using-the-sward-stick.pdf

Feed Allowance

Inadequate dry matter intake is a common underlying cause of worm problems on farms.

There are certain times of the year when it is important to have stock grazing at specific pasture covers to ensure that requirements for growth, pregnancy and lactation can be easily met. Farm systems that frequently underfeed their stock, are more likely to have problems with worms.

Examples:

Mixed age ewes rearing multiple lambs: Pasture covers at the time of initial set stocking should be a minimum of 1400kgDM/ha (4.5-5cm) and ideally not go below 1200kg DM/ha (3.5cm) after set stocking. (See: B+LNZ's 'Make Every Mating Count' https://beeflambnz.com/knowledge-hub/PDF/making-every-mating-count.pdf). These targets may be increased for triplets and lambing hoggets.

Weaned lambs: Minimum pasture covers of 1500kg DM/ha allows lambs choice so they can select the most nutritious parts of the pasture. By not grazing down into the bottom of the sward, the impact of larval intake is reduced. For more information on ewe and lamb nutrition, see B+LNZ's Growing Great Lambs subject page https://beeflambnz.com/knowledge-hub/growing-great-lambs

Weaned calves: Minimum pasture covers of 1600kgDM/ha for fast liveweight gain and reduced effects of larval intake. (See B+LNZ's Factsheet 'Growing Cattle Fast on Pasture' https://beeflambnz.com/knowledge-hub/PDF/growing-cattle-fast-pasture.pdf).

For control of pasture quality, a range of options should be available to avoid making susceptible stock graze into the base of the sward. Examples include adding cattle to lambing paddocks and following young stock in rotation with adults or another species. Rotational grazing at times of fast pasture growth enables paddocks to be dropped out of the round for conservation, cropping or deferral.

Metabolisable energy (ME)

The metabolizable energy content of feed, expressed as megajoules of ME per kilogram of dry matter (MJME/kgDM) is a key driver of animal performance, and ability to cope with worms.

As ME feed values increase, so does animal intake. Feeds with a lower ME require extra time in the rumen to degrade. When an animals' rumen is full, it stops eating, even if its energy requirements aren't met, so low ME feed limits intake.

Low ME feed in a worm management context is mature pasture with a high dead matter, stalk and seedhead components. Poorly made silage and hay are also low in ME but will usually contain no or extremely few worm larvae.

High ME feeds include green, leafy, high legume content pastures, various forage crops and supplements such as grains, pellets or biproducts such as palm kernel expeller and dried distillers' grain.

The advantage of crops and supplements in a worm context is that they can also have low or (in the case of supplements not fed on the ground) near zero levels of worm larvae on them. Use of supplements can be a very important part of effective worm management in calf rearing systems and on lifestyle blocks, where there is limited scope for worm management via grazing swaps and rotations.

Protein and parasites

Along with ME, protein in the diet plays a pivotal role in providing adequate nutrition to ruminants and enhances their ability to cope with worms. Ensuring adequate crude protein in the diet will lead to more rumen microbial protein available for digestion in the abomasum and absorption in the intestine.

Proteins in the body play an important role in immune function – the antibodies and cells that the immune system deploys against parasites are largely composed of proteins. Dietary protein is generally prioritised towards essential maintenance and functions such as growth, foetal development and lactation, ahead of worm immunity or resilience. Thus, the diet must supply protein in excess of these requirements for animals to effectively deal with worms.

Work in late pregnant and lactating ewes has shown that provision of extra dietary protein can reduce the extent and severity of the periparturient rise in faecal egg counts.

Some proteins are not broken down by microbes in the rumen; these so-called 'bypass proteins' provide an additional protein source for the animal to absorb. See below for more detail about the role of forages containing condensed tannins and bypass proteins.

Forage Type

Forages that have higher digestibility, metabolisable energy and protein than permanent pasture, drive higher rates of liveweight gain in young animals and allow them to get to a stage of maturity where they can maintain their own parasite immunity, faster.

Tannin-rich species such as Chicory, or especially sulla or lotus, may decrease the rate of larval establishment in the animal and help improve growth performance. Tannins also facilitate the 'bypass' of some of the protein in forage through the rumen, thus, extra protein is available for absorption in the small intestine, for both growth and parasite immunity/resilience.

What about trace elements and vitamins?

Copper, selenium, iodine and cobalt (in vitamin B12) are key components of ensuring optimal production in livestock, however supplying all the trace elements in the world will not replace providing adequate nutrition for animals. If these elements are found to be deficient through appropriate testing, then they can complement adequate feeding.

Copper in the form of copper oxide wire particles (given to stock as copper boluses) has been found to be beneficial in reducing the establishment of some parasites. It can reduce faecal egg counts by limiting the establishment of parasites that live in the abomasum, such as *Haemonchus* and *Teladorsagia* in sheep, and *Ostertagia* in cattle.

Copper boluses have a soft capsule which breaks down in the abomasum, releasing the wire particles, which then lodge in the folds of the abomasum and dissolve slowly over time.

Excess copper can cause poisoning in any species. It is important to seek advice from your animal health advisor and check copper levels before supplementing copper, especially in sheep whose copper requirements tend to be much lower.

Are parasites a cause of poor condition in ewes?

If ewes are allowed to get too light through underfeeding, mob pressure, or other causes, they are more likely to suffer the negative consequences of parasites.

In high challenge situations, parasites may be a primary cause of low body condition in a proportion of ewes. This can impact flock productivity and feed efficiency. If more than a small proportion of ewes are being impacted this way, it is an indicator of excessive pasture larval contamination.

A 2020 PhD thesis on wastage and culling in New Zealand ewe flocks found that parasites were the primary cause of poor condition in only 13% of cases in ewes examined at post-mortem. Typically, ewes impacted by parasites also had another cause for ill-thrift at play.

A 2020 analysis looked at how ewes responded to parasite treatments over lambing and early lactation. On average, treatment at this time gave a liveweight benefit. Ewes either lost less liveweight (for those that lost weight) or gained more liveweight (for those that gained weight). However, there were wide variations in ewe liveweight gain or loss that were not related to apparent parasite infection (measured as faecal egg count). The light ewes did not gain more weight in response to treatment than did their better conditioned counterparts. In addition, not all light ewes did gain weight after treatment with anthelmintics.

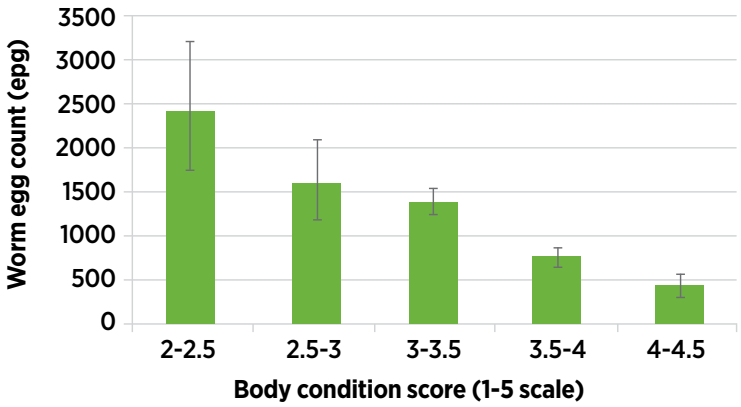
In a study focussed on the fate of individual light ewes in commercial flocks, light ewes treated for worms at ram removal lost less weight to scanning than light ewes left untreated, though both groups continued to lose weight while managed in a large mob.

The economic benefit of improving the liveweight of lighter ewes is greater than the benefit of improving ewes that are already in good condition. The above findings indicate that a substantial proportion of light ewes have become light for reasons other than parasitism, but that removal of parasites at key times can help some of them. Given that parasites are only part of the picture, it is vital that tools such as separation into a smaller mob and preferential feeding are also used, alongside effective culling decisions, as these tail end ewes can often be contributing more to pasture contamination.

The higher average faecal egg counts often seen in light ewes are frequently caused by a small number of individuals with very high counts.

An Australian study in 2013 showed that Merino ewes with a BCS of 2-2.5 had FECs averaging 1520 eggs/gram compared to ewes of BCS of 4+ with an average FEC of 328 eggs/gram.

Lower worm egg counts associated with higher body condition score



Source: Kahn et al 2013

Bibliography

B+LNZ's Feed Planning webpage:
https://beeflambnz.com/knowledge-hub/feed-planning

B+LNZ's book 'Making Every Mating Count'
https://beeflambnz.com/knowledge-hub/PDF/making-every-mating-count.pdf

B+NZ's Factsheet 119 'Growing Cattle Fast on Pasture'
https://beeflambnz.com/knowledge-hub/PDF/growing-cattle-fast-pasture.pdf

The influence of dietary protein on internal parasitism in sheep. McFarlane, R. Proc 29th Annual Seminar, Society of Sheep & Beef Cattle Veterinarians NZVA, 1999.

Copper Oxide Wire Particles to Control *Haemonchus contortus* in Sheep and Goats. Burke J, Miller J, Terrill T; 10th Anniversary Conference of the American Consortium for Small Ruminant Parasite Control, 2013.

An epidemiologic investigation of wastage and productivity of ewes in a sample of New Zealand commercial flocks. Griffiths, K. https://mro.massey.ac.nz/items/e761e441-89cc-4c33-812d-fb9362da5246

Nematode parasites are not a major cause of illthrift in adult ewes in New Zealand. Leathwick D, Ganesh S, Miller C. New Zealand Journal of Agricultural Research, 63:2, 165-178, 2020.

The life and times of tail end ewes. Cook T, Dodunski G. Proceedings of the Pan Pacific Veterinary Conference, Brisbane, 2010.

Lower worm egg counts associated with higher body condition score. Kahn L, Dever M, Bowers S. Proceedings of the World Association for Advancement of Veterinary Parasitology, 2013.

Chapter 4: Avoiding the worms

Think Wormwise, think F.A.R.M.ED

Avoid exposing susceptible animals to high pasture contamination.

An effective worm management plan will have a strong focus on reducing pasture contamination and its impact on stock.

Generally, worm development is in proportion to pasture growth. Warm, moist conditions speed parasite build-up; cold slows development; dry weather reduces larvae on herbage. Plan grazing to keep young stock off the most contaminated areas of pasture during periods of rapid larval build-up if possible.

Forages other than permanent pasture can reduce parasite challenge to susceptible animals and provide them with improved nutrition, while helping to reduce contamination of permanent pasture.

By and large, cattle, sheep and deer do not share the same worm species.

Planned integration of different livestock species or classes can reduce the overall worm challenge to each species, when done well.

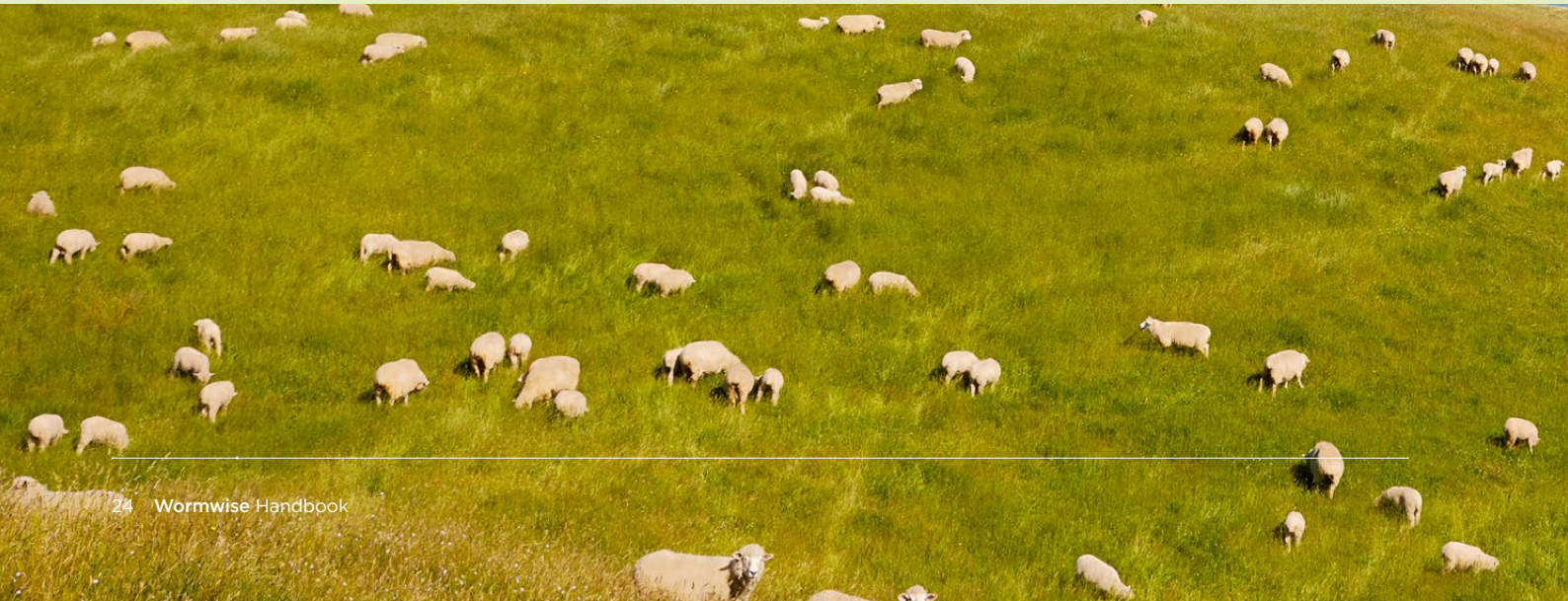
Healthy, well fed adult animals can be net removers of larvae from pasture.

At times, adult animals of the same species can be used to reduce the number of infective larvae on pastures.

Genetics - animals can be selectively bred for resistance or resilience to worms.

Animals can be bred to have a higher resistance to the establishment of worms, or to be more resilient to the effects of worms. Increased emphasis on these traits will result in faster genetic progress being made. In modern sheep breeding, index selection provides sires which perform well in maternal traits, as well as conferring improved parasite resistance or resilience to their progeny.

Genetic changes are permanent and cumulative. Over time, the result will be a lower need for drench inputs. Work in New Zealand selecting cattle for better ability to cope with worms is in its early stages.



Farm System design

Farm system design is a very important part of planning to 'avoid the worms'.

For example, finishing/youngstock grazing units with a high proportion of young animals on the farm throughout the year can become very contaminated, especially if the forage system is predominantly permanent pasture.

By comparison, finishing/youngstock systems with a high proportion of crop and new grass, or systems dominated by adult stock, such as dairy farms or sheep breeding units where lambs go elsewhere after weaning, can present much lower levels of worm contamination.

Utilising parasite life cycle and seasonality

Being familiar with the parasite lifecycle helps to understand how grazing management and stock class swaps might be used to reduce the build-up of larval contamination. Young stock rotating on their own area for long periods can build up 'hot spots' of both drench resistant worms and larval contamination.

Spelling pasture from grazing (preferably for three months or longer) can help reduce the level of larvae present; over time L3 use up their stored metabolites and die off (faster in warm conditions) before being able to complete their life cycle. However, such spells are rarely practical in New Zealand grazing systems; leader-follower grazing rotations where older stock or another species, follow behind young stock in rotation, or area swaps of several months, are likely to be more practical.

Having an appreciation of the different worm species and the time of year that they can be an issue is part of this planning. See Chapter 2 (Worm Biology) for details of the seasonal distribution of different worm species.

An example of management to reduce the effects of a seasonally predominant worm species could be a policy of having most trade lambs sold by the end of summer, and provision of an area of forage crop for replacement ewe lambs to avoid issues with *Trichostrongylus* later in the autumn. In *Haemonchus* areas, shifting lambs onto cattle areas in late summer could help reduce the contamination – exposure cycle for this parasite in lambs.

Utilising animal immunity to reduce pasture contamination

Age and size

Sheep, cattle and deer develop age-related immunity to worms. They begin to develop a level of immunity from around six months, which is 'fully' developed by 18 months of age. Therefore, it is important to avoid exposing susceptible young stock with under-developed immunity to high levels of infective larvae.

Development of immunity is related to percentage of mature size; a 45kg hogget at 6-7 months of age will have a better parasite immunity than the same age hogget at 35kg.

> Slow-growing lambs and calves are one of the largest sources of overall parasite contamination in farming systems.

As well as age and weight, body condition score can influence immunity, with lighter-conditioned animals more likely to be affected by parasitism.

Immunity lasts for life but requires some ongoing exposure to parasites. During periods of increased stress on the animal, such as late pregnancy, lactation or concurrent disease, immunity to parasites can decrease. If an animal is underfed at any stage, this can lower immunity to parasites as well, especially around lambing/calving.

Breed and genetics

Breed and genetics can also influence immunity. In general, fine-wooled sheep breeds have less robust immunity to worms than no wool/shedding breeds and coarse wool breeds. However, some of the observed differences may be due to the environment and nutritional management under which different breeds are run.

Genetics is a very valuable tool when used alongside good parasite management practices.

Selection within breeds has produced genotypes of sheep which are more resistant to worms than others. Resistant sheep mount an immune response to reduce or eliminate the population of worms in their gut, maintaining lower faecal egg counts than unselected or susceptible sheep. Over time, resistant sheep can reduce contamination on a farm, when well fed.

Previously when selecting for parasite resistance as a single trait, there was a drop in some of the production traits such as lamb & wool growth. However, by combining production and parasite resistance traits into an index, animals can be selected which are high performers and also have low FECs.

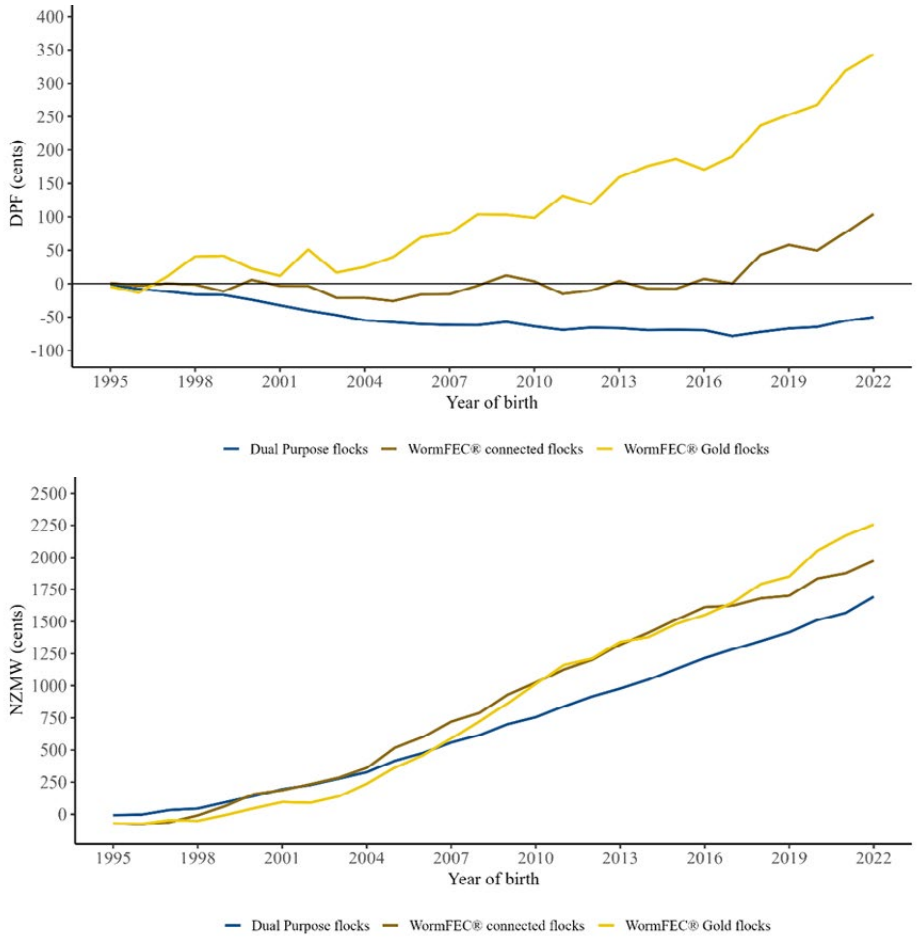
Studs submitting data to B+LNZ Genetics and selecting on NZMW and DPF (New Zealand Maternal Worth and Dual purpose FEC) are breeding such sheep. B+LNZ's nProve (www.nprove.nz) is an online tool that helps commercial farmers find breeders that are selecting for these traits.

WormFEC

Breeders actively recording and selecting sheep with a low FEC may be part of the WormFEC programme. Faecal egg count (FEC) data is used to generate estimated breeding values (eBVs) so they can rank and selectively breed stock with superior genetics. Elite breeders for this trait can be classified as WormFEC Gold.

By utilising the New Zealand Maternal Worth Index (NZMW) and the Dual Purpose FEC (DPF) Index for many years to retain animals that are both highly productive and have very good worm resistance, the WormFEC Gold breeders' average for NZMW now sits higher than the average for the rest of the industry:

Genetic Trends for Dual Purpose Faecal Egg Count (DPF) Index and NZ Maternal Worth Index (NZMW).



For fine wool, some breeders are registered with B+LNZ Genetics and on the nProve website, or some may be using the Australian system; MERINOSELECT and measuring YWECs (yearling worm egg counts).

The heritability (the proportion of variation in the progeny that is accounted for by genetics) of faecal egg count is moderately heritable, at 18%, similar to the heritability for number of lambs born (NLB).

CARLA®

CARLA® is another tool for selecting sheep with lower faecal egg counts. CARLA® is the acronym for Carbohydrate Larval Antigen. The test measures antibodies against worm larvae in saliva. This antibody response, measured using the CARLA® Saliva test, limits the ability of L3s to establish in the gastro-intestinal tract. This results in less adult worms establishing in the gut and lower FECs, leading to lower pasture contamination.

Studies have determined that, while most animals eventually express a detectable salivary CARLA® response, the timing and intensity is highly variable. The observation that this trait was heritable, has led to the development of the CARLA® Saliva Test as a means of selecting animals for breeding purposes.

The CARLA® antibody response is moderately heritable (30%) in young stock. Generally sheep need to be sampled only once. The genetic correlation between CARLA® and FEC is quite high at around 0.5. However, using CARLA® as a selection tool for reduced FEC will be a little slower than the genetic gain made by using FEC directly.

Work to validate the CARLA test in cattle started in 2025.

Resilience – avoiding the effects of worms

Animals may also be 'resilient' to parasite challenge. These animals do not appear to mount any significant response and appear not to show reductions in productivity in their first summer/early autumn under worm challenge.

Resilience in the face of a challenge from internal parasites is measured as no noticeable reduction in performance. Parasite loads are not relevant, even though some resilient animals may carry large worm burdens. The important thing is that they perform as well as animals without parasites. However, these animals will contribute to parasite contamination on pasture.

There are a small number of breeders selecting for resilience in their sheep flocks. The resilience testing protocol either starts at weaning, or 28 to 35 days after a weaning drench. Liveweight gains of lambs under evaluation are measured every 1-2 weeks and compared to a control mob under regular drench treatment. Lambs under evaluation whose liveweight gain falls under 80% of the control mobs' liveweight gain are drenched and drop out.

The evaluation finishes after 3-6 weighing events, when less than 30% of the evaluation group remain untreated.

Resilience has low heritability, at only 10%.

Animals with 'resilient' genetics may eventually go through a period of reduced performance if they gain some immunity later in the season.

The periparturient rise in ewes - avoiding the cost

The relaxation in immunity of some ewes around lambing time is termed the peri-parturient rise, where faecal egg counts may rise as some ewes temporarily lose some of their immunity against parasites.

The last few weeks of pregnancy see ewes undergoing big changes in metabolism and energy partitioning, plus fluctuations in hormones that drive the production of colostrum in the udder and maintain pregnancy in the final weeks. It seems likely that parasite immunity drops down the 'priority list' in some ewes.

This can be measured as an increase in faecal egg counts, which may start around 2 weeks prior to lambing. In mature crossbred ewes, FECs are often declining again by docking/tailing; in younger ewes and fine wool breeds it can continue for longer.

The PPR does not occur in all ewes, all mobs, or on all farms, and the consequences of it are highly variable and very dependent on the farm system.

There is plenty of research to show that ewes that are better fed (especially those fed high quality protein as well as adequate energy) have lower FECs over lambing than poorly or 'averagely' fed ewes, and ewes from genetic lines that are resistant to parasites also have a substantially lower PPR.

Animal gender and worms

There is some evidence that the sex of an animal can influence level of parasite immunity. Ram lambs can have higher FECs than ewe lambs and wethers can be in between. This may be a consequence of their relative level of maturity (and hence immune competence) at the same body size.

Using feeding strategies to avoid worms

Nutrition plays a pivotal role in developing and maintaining animals' immunity to parasites. A healthy immune system enables animals to avoid worms and minimise the negative effects of gastrointestinal parasites. Nutrition is provided in the form of different forages including permanent pastures and crops such as herbs and brassicas. It also includes fodder such as hay, silage, baleage, cereals, grains and nuts.

How paddocks are grazed and by what stock classes can greatly influence the level of larval challenge that susceptible animals are exposed to, as well as the quality of the feed on offer.

Grazing height

More worm larvae are found in the bottom 2cm of pasture, so managing susceptible stock on higher grazing residuals will decrease the amount of infective L3 consumed. Older animals or other stock classes can follow behind them in rotation to maintain pasture quality.

Forage type

Open growth habit forages such as brassicas, lucerne, chicory and plantain can be a less favourable environment for infective larvae. They typically also have better nutritional value which helps young animals cope better with worms.

Forages that have higher digestibility, metabolisable energy and protein than permanent pasture, drive higher rates of liveweight gain in young animals and allow them to get to a stage of maturity where they can maintain their own parasite immunity, faster.

Tannin-rich species such as Chicory, or especially sulla or lotus, may decrease the rate of larval establishment in the animal and help improve growth performance. Tannins also facilitate the 'bypass' of some of the protein in forage through the rumen, thus, extra protein is available for absorption in the small intestine, for both growth and parasite immunity/resilience.

For more information on feeding, see Chapter 3.

Cropping and pasture renovation

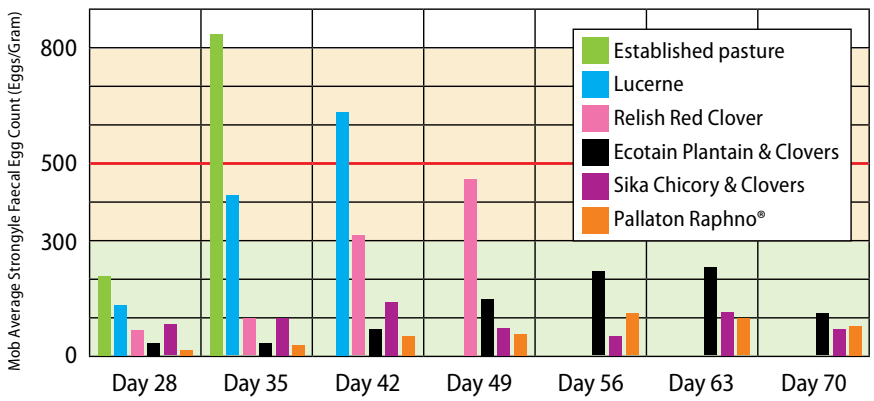
Cropping

The process of cropping can remove larvae from the existing pasture thatch and potentially disrupt some of the larvae resident in the top layer of soil.

Open growth habit forages such as brassicas, lucerne, chicory and plantain can be a less favourable environment for infective larvae. They typically also have better nutritional value which helps young animals cope better with worms.

Recent work comparing lambs grazing different summer forage crops showed that lambs on newly-established crops were able to be maintained at longer drenching intervals (and even no drench at all for up to 10 weeks in the case of Chicory and Raphno®) compared to lambs grazing older, contaminated crops or permanent pasture.

Worm Re-Infection Rates on Summer Forage Crops 2023-25



This is a graph showing the average Strongyle faecal egg counts (eggs/gram) from lambs drenched on Day O then grazed on the different forages from Day O to Day 70. Trials were completed by PGG Wrightson Limited in conjunction with PGG Wrightson Seeds Limited during the summers of 2023-2025 in Canterbury, Waikato, Southland and Tararua.

Pasture renovation

During the process of renovating pasture, whether it be into a temporary crop or updating permanent pastures, some parasite larvae can be removed. How many larvae will be removed depends on the process involved in the pasture renovation. Even without cultivation of the soil in a spray and direct drill programme, there can be a reduction.

Full cultivation is likely to remove more larvae than direct drilling. Traditional ploughing, where the top layer of soil is physically buried, is likely to be most effective, but all methods that disrupt the top few centimetres of soil and expose larvae to air and UV light are helpful.

- In a direct drilling situation, factors that affect larval removal can be:
  - Number of sprays
  - Success of spray-out: Green vegetation left behind is a larval habitat
  - Time between spraying and re-planting: A short interval allows less time for drying effect and UV light to remove larvae
  - Residual pasture into which seed is drilled: More thatch left means greater larval habitat, conversely, more UV light to ground level should mean better larval die-off
  - Rate and extent of regrowth of green grass (and/or green weeds) post-spray out: Green vegetation that has regrown is a larval habitat; larvae can re-colonise this from the soil.

Direct drilling outcomes are likely a continuum of larval removal where more time, more drying and more UV light to ground level result in less larvae surviving the process.

Remember that unless the renovated area goes right to the fence, the grass left around the outside can still be contaminated with parasite larvae. This can be a cause of 'unexpected' worm challenges on crops, and should be monitored, with management put in place to minimise the effects. Possible approaches are:

- Starting young animals on the crop (with or without transition/run-off paddocks) and treating them for worms once they have stopped heavily grazing the edges and grass areas
- Performing a faecal egg count at 28 days after introduction to the crop and drench if the results and observation of the animals indicate this is required.

Integration of stock classes and animal species to avoid worms

Cattle, sheep and deer, by and large, don't share parasites. Goats and sheep share the same parasites. Utilising this knowledge in grazing plans can allow worm larvae on sections of the farm to be 'cleaned' up by grazing with another species. As described above in the section on animal immunity, integrating older animals of the same species can also be part of this approach, but they must be well fed so that their immunity is maximised.

Alternating grazing species

Incorporating cattle and deer into lamb grazing areas can reduce larval challenge to lambs. Note that goats are not a suitable species to integrate with sheep for worm management purposes; they share the same worms as sheep and are generally considered to be net contaminators rather than removers of worm larvae.

For calves; sheep, deer and goats can be integrated to reduce worm challenge.

Pre-grazing pasture with alternative stock may take some months, depending on initial contamination levels, to clean up an area enough that improved growth rates and reduced drench use can occur in the class of stock that the pasture is being prepared for. Improved growth rates have been recorded where areas of a farm are grazed by one species for a period of time and animals are swapped between blocks.

On mixed species farms, it can be easier to use a mix of alternative species, and older, immune animals of the same species, to prepare pasture for young stock.

Below are some general guidelines that could be applied. These are examples of worm management grazing strategies but are not an exhaustive list and may not apply to all farms.

Sheep:

As lambs are the main larval contaminators, ensure the farm system is set up to wean heavy lambs and finish the remainder as quickly as possible.

Anything you can do to avoid having lambs rotating around their own area of permanent grass after weaning, will help.

If possible, prepare areas for weaning lambs onto by utilising other classes/species of stock, rather than weaning back onto lambing areas. This may be part of an integrated strategy with other forages available for weaning also.

Where this is not possible, an alternative approach can be to graze lambs at high pasture residuals (so they can have choice and select the best quality pasture components), on long rotations, with as many other stock classes following them as possible before they return to where they grazed previously. Thus the 'follower' stock classes remove worm larvae whilst being utilised as necessary for managing pasture quality.

In sheep breeding-finishing systems, be aware that much of the worm challenge that ewes will face at lambing comes from over-wintered contamination laid down by lambs in the previous autumn. Think ahead when planning lamb sales and grazing strategies, with this in mind.

Cattle:

In beef breeding systems, try to avoid weaning calves back onto parts of the farm they grazed in the previous spring/summer with the cows for any substantial period of time. Wintering on crop can help reduce worm challenge to beef-reared weaners in their first winter.

In dairy/dairy beef systems, offering calves low challenge feed in their first summer & autumn will ensure they perform much better. Use of forage crops, hay or silage aftermath or alternate grazing with adult cows or other species such as sheep or deer are all options. Utilising high energy supplements helps artificially reared calves cope with worms more easily in their first summer. As with lambs, avoid having young calves rotating around their own area of permanent pasture with drench as the only means of limiting worm larval build-up.

Bibliography

Controlling internal parasites in grazing ruminants without recourse to anthelmintics: approaches, experiences and prospects. Niezen J, Charlston W, Hodgson J, McKay A, Leathwick D. International Journal for Parasitology Vol. 26, No. 8/9, pp. 983-992, 1996.

Protein supply influences the nutritional penalty associated with the development of immunity in lambs infected with *Trichostrongylus colubriformis*. Greer A, Sedcole R, Jay N, McAnulty R, Green R, Stankiewicz M, Sykes A. Animal (2009), 3:3, pp 437–445.

Keeping the worms at bay. Thatcher A, New Zealand Dairy Exporter July 2012, 116-119.

B+LNZ Sheep Improvement Limited Technical Notes https://www.sil.co.nz/technical/technical-notes

Effect of herbage species and renewal technique on the free living stages of gastro-intestinal roundworms. Moss R, Dynes R & Goulter C. New Zealand Journal of Agricultural Research, 54:1, 15-22.

Using forage crops to reduce worm challenge in lambs. Leslie J, Westwood C, Dowling A. PGG Wrightson technical information sheet April 2025.

Influence of sex and reproduction status on susceptibility of ruminants to nematode parasitism. Barger I. International Journal for Parasitism 23(4): 463-469, 1993.

Typical males - do male lambs contribute more to pasture larval contamination? Oswald, A. 2025 Conference Proceedings of the Sheep and Beef Cattle Veterinarians & the Deer Veterinarians Branches of the NZVA, pp 31-36, Jun 2025.

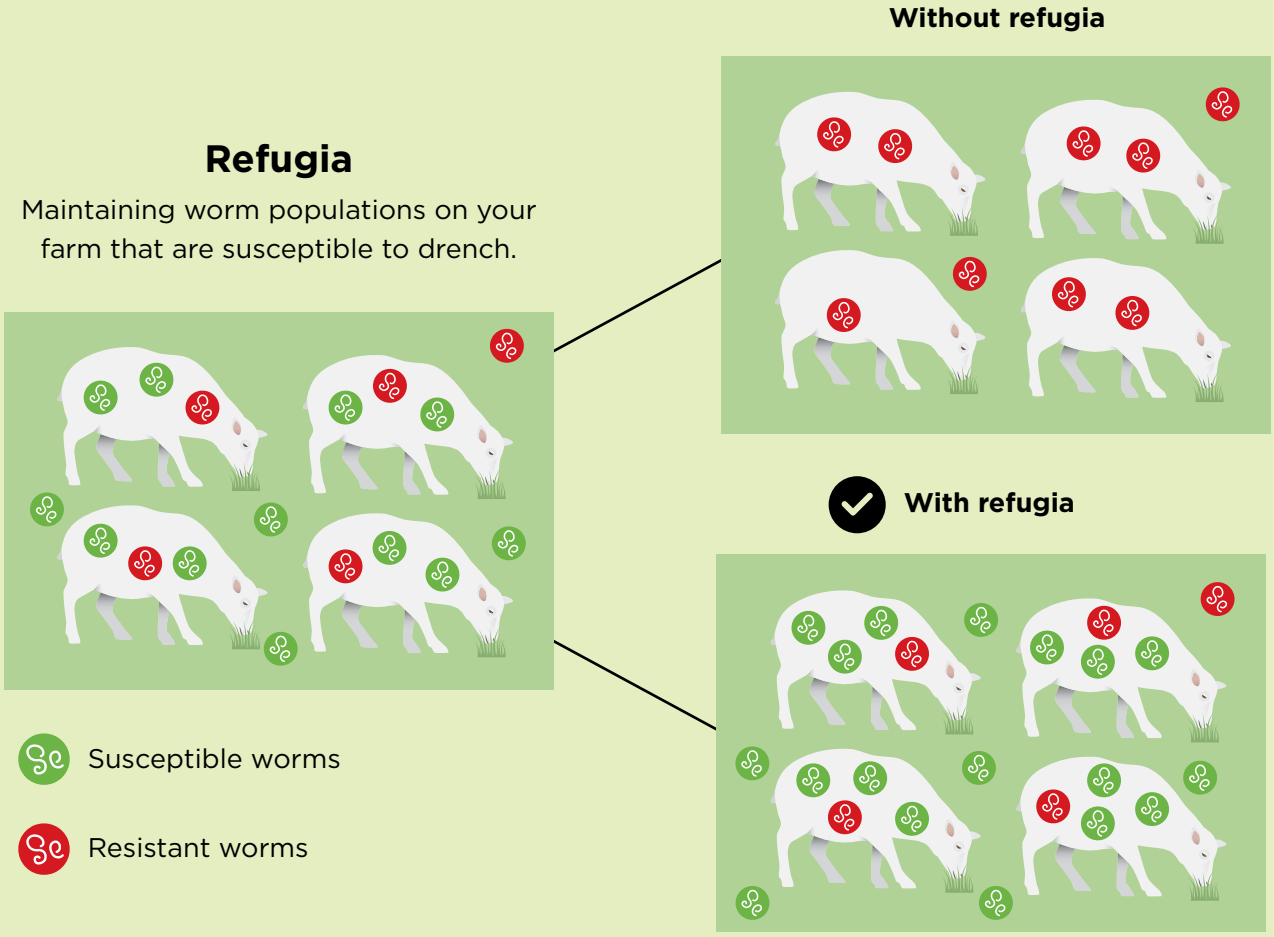
Factors that may affect larval removal in a cropping or re-grassing programme. Westwood C, Pers. Comm. September 2025.

Chapter 5: Refugia

Refugia - Don't let the drench survivors dominate.

Refugia refers to the portion of a parasite population that is not exposed (in refuge) to drench treatment. This untreated pool preserves drench-susceptible genes and dilutes those from resistant survivors, slowing the development of drench resistance in the worm population.

The amount of refugia that is required depends on drench efficacy. If the drench used is letting a lot of worms survive, more refugia is required to dilute out the resistant worms. Monitoring drench efficacy is critical.



Refugia

'Refugia' at its simplest, means making sure there are some drench-susceptible worms available to reproduce, so that the worm population on the farm does not become more drench-resistant over time. If drench-surviving worms mostly breed with drench-surviving worms, the result is more resistance.

The idea is to create a "refuge" of worms and to ensure this reservoir of drench-susceptible worms significantly outnumbers drench-resistant worms.

This refuge can exist on pasture as susceptible larvae and inside animals as susceptible adult worms. These can breed with each other (progeny = susceptible) and with resistant worms (progeny = variable, but better than being all resistant).

Methods to achieve Refugia

There are three broad methods:

1. Having young animals share grazing areas with older, undrenched animals. In this system, the older animals provide susceptible larvae to 'dilute out' any drench-surviving larvae being added to the paddocks by the youngsters. The older and younger animals do not need to graze the same paddocks at the same time but should share the same grazing area within the same part of the year.
2. When young animals are under regular preventive treatment for worms, extending treatment intervals so that there is more time between treatments for susceptible worms to establish and breed with each other, and with drench survivors. Monitoring is important to do this safely. Extending drench intervals is typically easier on areas that have been intentionally prepared to have a lower worm challenge. However, it can also work on more contaminated areas if young stock are grazed lightly and allowed to eat the best quality feed before moving on.
3. When drenching mobs of animals, leaving a proportion of them untreated. In this system, animals within the mob become the source of susceptible larvae in the paddocks being grazed.

Examples of using undrenched adult/older animals:

- Using un-drenched ewes to graze pasture previously grazed by drenched lambs. The susceptible worms shed by the ewes "dilute" the population of resistant larvae left behind by the lambs. An alternative to this is drafting out light ewes, not drenching them and running them together with lambs.
- Following R2 cattle behind calves or running light R2's in with calves.

Example of extending drench intervals:

- Instead of a routine drench at 28 days, faecal egg counts are performed and the results used to determine whether a drench is required immediately, or whether the drench interval can be extended. It is critical to interpret the FEC results alongside other factors such as weight, growth rates, body condition and how the animals are looking. The feed available, climatic conditions and grazing history also need to be included when interpreting FEC results. Some farmers extend drench intervals without testing and will use close visual observation of the stock, plus the information above, to make the next drench decision.
- Extending drench intervals is easier to do where young stock are grazing an area that has been prepared to provide them with lower worm challenge. In these situations, refugia becomes more important because there will be lower numbers of larvae on pasture, increasing the risk that drench-surviving worms become predominant on pasture.

Examples of leaving animals untreated within mobs/herds:

- Leaving a small number of the heaviest or best conditioned and treating the remainder (more suited to animals under 6-9 months of age where it may be unsafe to leave a large proportion untreated)
- Treating on individual FEC (on small blocks)
- Treating only the poor conditioned (more suited to adult ewes and cows, R2 cattle)
- Treating animals that fall below a pre-determined liveweight gain target (when weighing regularly). This is termed Targeted Selective Treatments (TST) - see below.

Targeted selective treatment (TST)

Under a Targeted Selective Treatment (TST) system, animals are individually identified and need to be weighed regularly (monthly is suggested). Individuals whose liveweight gain for the period falls below a pre-determined target are drenched, and those above the target are left untreated.

New Zealand research on TST has highlighted the potential of this approach to substantially reduce total drench inputs while maintaining production.

The use of TST in winter lambs reduced total requirements by 50% with no production loss.

B+LNZ Final project report: 'SmartWorm® App Pilot Study'
https://beeflambnz.com/knowledge-hub/PDF/smartwormr-app-pilot-study.pdf

B+LNZ Final project report: 'SmartWorm® App - Case Studies'
https://beeflambnz.com/knowledge-hub/PDF/smartwormr-app-case-studies.pdf

Studies in dairy heifers from weaning to first mating showed an even more substantial reduction in drench used, with a small difference in mob liveweights at first mating. In this work there were several weighing episodes where the trial protocol dictated that a large proportion of the TST groups were left untreated because their liveweight gains were above target.

In a real-life scenario, practical approaches to better ensure productivity whilst creating refugia could be:

- To raise the liveweight gain target at certain times in the season, as liveweight gain can be expected to vary depending on feed and climatic conditions.
- To set a maximum percentage of the mob to be left untreated, for example 20 to 30%. When beginning with a TST approach, it may be more comfortable for farmers to start this way.
- Starting a TST programme once young animals have reached a certain liveweight. For example, the first 2-3 treatments are given to the whole mob (with other management in place to provide refugia) then TST is commenced at the 4th treatment.

Notes on managing refugia on pasture

New grass or 'clean' grazing areas:

In most cases, it's wise to avoid drenching animals directly onto areas of new grass or 'clean' grazing. Remember for the first 21 days the only eggs coming out in the faeces will be from worms that have survived the drench. Options for providing refugia include:

- Grazing the area lightly with undrenched ewes first to allow some susceptible parasites to 'seed' the pasture.
- Graze with young stock that are 'due' for a drench and thus should be shedding at least some eggs from susceptible worms. Note that the more drenches these animals have had prior, the higher the percentage of resistant worms they are likely to be carrying.
- Utilise TST and leave the best performing young stock undrenched.
- Initial grazings of genuine new grass paddocks are typically short in duration, so if you do have to graze them with young stock within 21 days of a drench, try to follow with undrenched animals.

Ordinary grazing rotations on permanent pasture:

While there may be some differences in both pasture contamination and worm challenge between paddocks, it is unlikely that the next paddock in the grazing round will be substantially 'cleaner' than the one before it, especially in sheep-dominant systems where ewes have lambed over most of the farm.

In these situations, the timing of drenches should be based on the need of the animals, and the timing of shifts on both animal requirement and pasture management principles. Refugia can be provided in the ways described.

Putting young animals back into the paddock they have come from after drenching is no guarantee that they will pick up more susceptible worms than they might from their next paddock (plus, for the next 21 days any eggs they contribute to pasture will be drench survivors anyway). Also, many drench chemicals are active in the body for a day or two - in this time, only resistant larvae may establish, so a couple of days back in the same paddock makes no difference. Finally, if returning young animals to the same paddock sees them consuming low quality feed, liveweight gain and hence progress towards developing their own immunity, is compromised.

How do we know refugia practice will work?

An earlier trial funded by Beef + Lamb New Zealand showed that leaving 10 or 20% of lambs undrenched, resulted in a significantly lower level of drench resistance in the subsequent worm population, when compared with a system of all animals being drenched.

This is the first research in the world to show that using refugia as a management tool can dilute resistant worms on pasture.

A finding from this trial was an increase in the level of larvae on the pasture in the farmlets where some lambs went untreated. Some increase in larvae on pasture has to happen for refugia to work. The essence is to allow enough worms through to dilute the drench-resistant ones without significantly compromising animal productivity. This is where management of pasture contamination via grazing integration and other means is very important.

Work from Scotland has shown that both Targeted Selective Treatment, or an extended drench interval programme were both able to reduce drenching frequency and maintain levels of production, while slowing down the development of anthelmintic resistance.

In more recent New Zealand work on a commercial TST programme (Smartworm®), an initial pilot study on the East Coast of the North Island showed a 49% reduction in the amount of anthelmintic used in the SmartWorm® groups, relative to the blanket treatment option. Overall, cumulative liveweight gain was no different between blanket-treated and SmartWorm® lambs. A further nationwide study was carried out on 7 properties, where a 48% reduction in drench usage was consistent with the previous pilot study and in agreement with overseas studies.

Putting refugia into practice

Exact recommendations on how to create refugia will vary between farms, for example, when best to leave stock undrenched, what proportion to leave undrenched and what implications there might be for production.

The challenge is to find ways to maintain low levels of pasture infestation yet retain a useful pool of susceptible worms.

Extending drench intervals or leaving young stock in a group undrenched are safer when the quality and quantity of the feed available is good, lambs are up to target weights and pasture is “clean”.

If feed supplies are low or poor quality, there is a greater risk that parasitism in undrenched stock will impact on production.

If you are not using TST to identify animals which require treatment, and wanting to select animals to leave untreated, start conservatively, i.e. start by leaving no more than 5% lambs or calves undrenched.

Choose animals in the best condition to remain undrenched. These undrenched animals can be identified and drenched next time round, however it does not matter if the same animals are excluded at each drenching, as long as their condition and performance is good.

Regular drench checks should be carried out through the season to ensure the drenches being used are effective. If routine drenches are letting a lot of worms survive, a lot more refugia is required to dilute out the resistant worms – this is a recipe for wormy pastures and unhealthy stock!

Bibliography

Refugia - why, how and how much? Leathwick D. Proceedings of the Society of Sheep and Beef Cattle Veterinarians of the NZVA, 2008. 85-89.

Reduced anthelmintic use on 13 New Zealand sheep farms: farmer motivations and practical implementation. Ridler A, Hytten A, Gray D & Reid J. New Zealand Veterinary Journal, September 2024.

Liveweight gain of grazing dairy calves in their first season subjected to a targeted selective anthelmintic treatment (TST) regime. Mcanulty R, GIBBS J & Greer A. Proceedings of the New Zealand Society of Animal Production 2011. Vol 71: 301-303.

Targeted selective treatment of R1 dairy heifers with anthelmintic: effects on performance. Bates A. 2021 Conference Proceedings of the Sheep and Beef Cattle Veterinarians and the Deer Veterinarians Branches of the NZVA. 67-68.

B+LNZ Final project report: 'SmartWorm® App Pilot Study'
https://beeflambnz.com/knowledge-hub/PDF/smartwormr-app-pilot-study.pdf

B+LNZ Final project report: 'SmartWorm® App - Case Studies'
https://beeflambnz.com/knowledge-hub/PDF/smartwormr-app-case-studies.pdf

Chapter 6: Monitoring

Think Wormwise, think
F.A.R.**M**.ED

A combination of tools can be used to monitor the **impact of worms on stock**. These can include specific diagnostic tests for worms, good observation, weighing and body condition assessment, as well as monitoring of feed and grazing history.

Monitoring drench performance should never be done 'by eye'. Faecal egg counts are a critical first tool for assessing the efficacy of drenches.

Monitoring

There is a saying: "If you can't measure it, you can't manage it". Monitoring is an important part of any management strategy.

The specific tests used in monitoring are:

- Faecal egg counts (FEC)
- Faecal larval culture
- GIN PCR - a test that amplifies worm DNA to identify worms by species
- Lungworm larval counts
- Faecal egg count reduction test (FECRT)
- Blood tests: Fluke antigen and Pepsinogen.

These diagnostic tests can help measure the success of your management strategies. Often the trends seen over time are as important as the individual results. For example, a change in grazing strategy of young stock may result in lower faecal egg counts at pre-drench monitoring, or a focus on ewe nutrition and condition leading to lower FECs in these.

Unfortunately, there are currently no commercially available methods to directly measure infective larvae on pasture.

The emphasis in this section is on the specific diagnostic tests for worms, but also very important are:

- Good observational skills
- Regular weighing and body condition assessment of stock
- Good feed planning.

Faecal egg counts

A faecal egg count (FEC) is a measure of the number of egg-laying adult worms in an animal's gut. For flock/mob examinations, faecal samples from a minimum of 10-30 animals are required to account for variation between individual animals. Faecal egg counts from individual animals are preferred, though a 'composite' faecal egg count (where one count is performed on a sample of many faeces mixed together) may be undertaken for practical/economic reasons.

Faecal egg counting does have limitations:

- Only mature female adult worms lay eggs, so mature male and immature worms are not detected.
- Identification of worms is limited because the eggs of several species are indistinguishable.

Collecting faecal samples

Clean, impervious containers such as plastic freezer bags or plastic pottles are ideal for collecting faecal samples.

Some points to note:

- Only one sample per container for individual samples (at least one tablespoon; more is better if species identification will also be required).
- Faeces must be fresh when collected (still warm; create steam in pottle or bag).
- For cattle samples, take faeces from the middle of the dung pat, rather than the edges. Eggs hatch on exposure to air, sampling from the middle avoids missing eggs that have already hatched.
- At least 10 individual samples are needed to give a meaningful result for a mob.
- If undertaking a composite sample, 20 to 30 individual faecal pat subsamples of equal volume should be included in the mixed sample. If sending samples off for testing keep the individual samples separate and let the lab/clinic mix equal amounts of each sample to create the composite sample.
- Keep samples in a cool place. If they cannot be examined on the day they are collected, store them in a cool place, e.g. fridge, not freezer.

Who does faecal egg counts?

There are lots of ways of having faecal egg counts done. Many veterinary clinics run an in-house FEC service, or they may send the samples to a commercial laboratory. Some farmers have learned to do their own counts and have purchased a microscope to do their own FEC testing. There are a number of commercially available automated FEC systems available for on-farm testing; for many of these it is not economic to do individual faecal egg counts and most tests run through these machines produce composite counts.

Individual or composite faecal egg counts?

Individual egg counts:

- 10+ samples are collected and processed separately, to give a FEC in eggs per gram (epg) from each animal.

Advantages of individual FECs:

- A guide to the distribution & range of FECs within a mob.
- In older lambs/calves and in adult animals, the 80/20 rule often applies: '80% of the eggs come from 20% of the animals' - this pattern is easier to pick up with individual samples.

Disadvantages of individual FECs:

- Cost and time to process.
- Risk of over-interpretation.

Composite faecal egg counts:

15–30 samples are collected. Ideally, a standard volume is collected from each dung pat, and the samples are thoroughly mixed together. One or more subsamples from the bulk mixed sample is processed and read as an average FEC for the mob.

Advantages of composite FECs:

- Speed and reduced cost per sample.
- Ability to monitor more frequently with automated systems - it's easy to see whether FECs are tracking upwards or downwards, and easy to run comparisons between mobs.

Disadvantages of composite FECs:

- Lack of detail. The average result can be skewed by a few very high or very low values.
- FEC results that fall into a 'middle' range can thus be hard to interpret.
- A way around this is to do repeat counts (say 3) on the same bulk sample and increase the frequency of monitoring to see whether FECs are rising or falling.

Cattle FEC testing

In cattle there is less of a relationship between FECs and total worm count. However, the relationship in calves 6 months of age and under is better. Calf FECs tend to follow a similar seasonal pattern – rising to an autumn peak and remaining moderate-low over winter.

Using 10 individual samples is possibly more important for cattle. A mean egg count of 50 epg ('low') could contain a number of counts which have greater significance than the same counts in sheep.

See B+LNZ's webpage 'Interpreting Faecal Egg Counts' https://beeflambnz.com/knowledge-hub/blnz-wormwise-programme/worm-diagnostics/interpreting-faecal-egg-counts for more information on interpreting faecal egg counts.

Worm species identification

Larval cultures

Larval cultures involve hatching the eggs in faeces, growing the worm larvae to the infective stage (L3) in the laboratory (this takes 10 to 14 days), and then visually identifying them. This is one of two options commercially available to identify the type of worms present in live animals.

Although the eggs of *Nematodirus* are distinctive, the eggs of the other economically important worms e.g. *Haemonchus*, *Teladorsagia*, *Trichostrongylus*, *Ostertagia* and *Cooperia* are virtually identical under normal microscopy and are reported in faecal egg counts as Strongylate eggs.

Larval cultures do not give a measure of the size of the worm burden, only the genus present.

GIN PCR

Another option for worm identification is GIN PCR. This test amplifies up genetic material (DNA) extracted from worm eggs to determine what species of worm is present. This test gives a faster result than larval culture, due to larvae not needing to be hatched.

Emerging and future worm identification technologies

Haemonchus eggs can be identified via a commercially available assay (Parasight®) which stains only the eggs of this species so that they fluoresce under a specific wavelength of light. This test currently has limited availability in New Zealand. In time it is probable that other high speed worm species identification tools will be commercialised in New Zealand.

When to use faecal egg counts

- To test if worms are part of the reason that an animal or mob is sick or performing poorly.
- To determine how quickly young animals are becoming reinfected after a drench; giving an indication of how contaminated the pasture is that they have been grazing on. A faecal egg count at 28 days (FEC28) may show low or even zero FECs if lambs or calves are grazing low-contamination feed and/or high residuals or may be moderate to high if grazing short covers on contaminated feed.
- To see if there is a need for drenching. Repeated testing from 28 days after a drench, rather than simply re-treating, can be a means of safely extending drench intervals and providing refugia. If the FEC is low, it may be possible to re-test a short time later (anywhere from a few days to 2 weeks), using the rate of FEC rise as an indication of when to treat again. As lambs or calves get older and start developing their own immunity, a FEC result may indicate that there is only a need to treat the poorer performing or lighter animals in the mob and leave the best untreated.
- Checking drench effectiveness (Drench Check, FEC10):
  - Collect 10 fresh faecal samples 10 days (7-14 days) after treatment.
  - If eggs are found in these faecal samples, then either the drench is not being administered correctly, or drench-resistant worms are present. A positive test should be followed by further testing to determine the severity of the problem and which worms are resistant, in consultation with your animal health advisor.

Interpretation of FEC results depends on animal factors such as age, reproductive status, breed, genetics and current performance, as well as management factors such as previous grazing history and current feed on offer. Further information can be found on the Beef + Lamb New Zealand Wormwise webpage 'Interpreting faecal egg counts' https://beeflambnz.com/knowledge-hub/blnz-wormwise-programme/worm-diagnostics/interpreting-faecal-egg-counts

When to use larval cultures

Larval cultures are one of the tools available to determine what genus of worm are present in a faecal sample.

This information is important when testing the efficacy of drenches, to know which worm genera are surviving the drench treatment. See below for further details on faecal egg count reduction tests.

In standard larval cultures, 100 larvae are counted, and the number of each worm genera counted are expressed as a percentage of the total egg count. In quantitative larval cultures, all larvae are counted and their numbers expressed as a percentage of the total larval count. Both methods produce results that can be highly variable.

Larval cultures are a guide to the worm genera present, but the percentages expressed are by no means exact. Apparent changes in drench performance over time can sometimes be a consequence of this variability, and care should be taken in interpreting upward or downward movements in absolute reduction percentages, especially if only comparing between two points in time.

Another use for larval cultures is in estimating the seasonal prevalence of different worm species on farms. Notwithstanding the variability inherent in larval cultures, they can still be a useful tool to track the rise of the more pathogenic worm species on a farm through the year, such as *Haemonchus* and *Trichostrongylus* in lambs.

When to use GIN PCR

As GIN PCR (Gastrointestinal Nematode Polymerase Chain Reaction) doesn't rely on hatching of larvae, this DNA based test gives a faster result compared to larval culture for identifying what worm species is present. This is important when a timely decision is needed such as diagnosing parasitism in a sick animal or Barber's Pole detection in a flock.

GIN PCR can also be used to determine what worm species has survived a drench when conducting drench checks. However, as GIN PCR does not currently give a numerical value, it cannot be used for calculating percentage reductions that are needed for faecal egg count reduction tests.

Lungworm larval counts

Identifying lungworm involves the isolation of L1 larvae that are passed in the faeces, not eggs. This process is a different method to that used when identifying gastrointestinal parasites. It is called the Baerman Test. Faecal samples are collected as normal and then samples are normally sent to a commercial laboratory via the farmers veterinary clinic.

Liver fluke egg counts

Liver fluke eggs can be counted in faeces via the 'sedimentation technique', where the faeces are mixed with a known amount of water, strained, and then the heavy fluke eggs allowed to settle to the bottom. They are then collected, stained and identified under a microscope. Fluke eggs are distorted by the floatation solutions used for nematode eggs, so can't be counted in a standard FEC.

The presence of fluke eggs in faeces indicates fluke infection in the animal. However, fluke produce eggs sporadically there is no relationship between the number of fluke eggs counted, and level of fluke infection.

Liver Fluke faecal antigen test

Veterinary clinics in New Zealand are able to offer a faecal ELISA (Enzyme-Linked- Immunosorbent-Assay) test for liver fluke. This test can detect immature and non-egg laying fluke if they are present in the bile ducts of the liver.

Tapeworm egg identification

Tapeworm eggs may be identified in routine FECs, but there is no relationship between the number of eggs seen and the number of tapeworm in the animal.

Faecal Egg Count Reduction Test (FECRT)

The FECRT is a 'before and after' test based on faecal samples taken from individual animals, which are treated with one or more different anthelmintics, to assess the efficacy of these.

Faecal samples are collected from lambs or calves on the day they are treated, and FEC's and larval cultures performed on these individual samples, to quantify how many of each worm genera were present prior to treatment.

Example of pre and post drench larval culture results from a FECRT

	Day 0	Day 10					
		Oxfendazole	Levamisole	Abamectin	Moxidectin	Double	Triple
Haemonchus	38%	8%					
Teladorsagia	2%	56%	26%	22%	30%	14%	64%
Trichostrongylus	36%	22%	74%	74%	68%	86%	36%
Cooperia	16%	8%		4%	2%		
Oesoph/Chabertia	8%	6%					
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

None of the drenches tested appear to be properly controlling Teladorsagia and Trichostrongylus, as they are present in the post-drench cultures of all products tested, and generally at higher proportions than on day 0. Cooperia appears to be surviving oxfendazole, abamectin and moxidectin in small numbers.

Seven to 14 days later, those same animals are sampled again. The faecal egg counts after treatment enable a percentage reduction in egg count to be calculated. Larval cultures performed on the post-treatment samples enable this reduction to be reported at the worm genera level. This is very important – an 'overall' reduction without worm genera information can 'hide' a poor reduction in one worm type.

Example of percentage egg count reductions by species from a FECRT

**Oesophagostomum/Chabertia*

Worm type	*Nematodirus*	*Haemonchus*	*Teladorsagia*	*Trichostrongylus*	*Cooperia*	*O/C**
Pre drench FEC (eggs/g)	50	336	118	319	142	71
Post drench FEC (eggs/g)	35	22	151	59	22	16
% Reduction	30%	93%	0%	82%	85%	77%

In this example in the table, all species are considered to have drench resistance (a reduction in worm egg count of less than 95%).

A full FECRT, including several different drench families at one time may be used to look at the extent of drench resistance on a property. This type of test is more common in sheep, where large numbers of lambs are typically available around weaning.

In cattle, it may be more practical to perform a series of these tests over time, using one drench at a time. It can be logistically difficult to organise large numbers of undrenched calves with sufficiently high egg counts to perform a multi-treatment FECRT.

This test should be conducted by an appropriate adviser to ensure faulty drenching practices are not the cause of the problem. Prior to starting the FECRT, it is important to check that the FECs of the mob are high enough to give a meaningful result.

Blood tests

Liver fluke antibody ELISA (sheep and cattle)

Liver fluke antibodies can be detected in blood samples for up to 12 weeks post-infection. Results are reported as 'negative', 'low' 'moderate' or 'high'.

Pepsinogen (sheep and cattle)

The pepsinogen test detects an enzyme that is raised in the blood of animals suffering from damage to the glands lining the abomasum. The most common cause of raised pepsinogen in grazing animals is damage from *Teladorsagia/Ostertagia*.

Health checks and general monitoring

Worms can cause ill-thrift and/or scouring in stock, but these signs can also be caused by other factors. Discuss observed problems with your veterinary adviser to determine the cause before simply doing more drenches or changing drench types. FECs and other diagnostic tests described above may be part of the investigation.

Good observation of stock, including appearance, general demeanour and grazing behaviour, is part of worm monitoring. Sometimes these aspects may change before a worm challenge shows up as a change in FEC. Data from weighing, body condition scoring and feed planning (grazing residuals and grazing history) all help inform worm monitoring and can improve the quality of decisions made. Worm monitoring is not just about drench and faecal egg counts, just as worm management is not just about drench timing and choices.

Chapter 7: Effective Drenching

Think Wormwise, think F.A.R.M.ED

Correct use of a highly effective drench, when required, ensures that maximal numbers of parasites within the animals are killed. Important outcomes of this are:

- Less contamination of pasture with drench-surviving worms
- Performance of treated animals is not compromised by worms left behind after drenching.

It is not possible to tell if a drench is highly effective simply by observation of stock after drenching – testing is required.

Drench in the farm system

Drenches are only one of the tools in the parasite management toolbox. For too long, they have been used as the only tool. The more that New Zealand sheep and cattle producers can set their farm systems up to have less dependence on drench to maintain production, the less of a threat drench resistance will become.

That said, as drench resistance becomes more prevalent on New Zealand farms, it is critical that the performance of the remaining effective products is protected. Regular testing of drench performance on your farm is essential. Continued use of ineffective products is a major contributor to the build-up of drench resistant parasites.

An important part of protecting drench performance is to have an appropriate quarantine drench protocol in place. This is particularly important for finishers, traders, and anyone who buys in their ewe lamb or heifer calf replacements.

This chapter will cover considerations for drenching stock at different times, followed by technical details about drench products.

Young stock

Lambs

Drenching lambs at docking/tailing

A drench to young lambs at this time is typically not necessary. Until a lamb has a fully functioning rumen (after about 5 weeks of age), a number of the common worm species cannot complete their development in the gut. In addition, lambs don't tend to suffer production losses from the worms they ingest in their early weeks, partly because of the protective effect of milk in the diet, and partly because their immune system does not start reacting to worms till later in life (see chapter 1, page 9 for more details).

Any scouring seen in young lambs is likely to be a consequence of the tiny threadworm *Strongyloides*. This parasite has a different life cycle than the other worms described in this handbook, being picked up through skin contact with the ewes' udder and very quickly expelled by lambs in their early weeks of life. Treatment is not usually necessary.

Mismothered lambs will often scour, and this may be a combination of ordinary gastrointestinal worms, and a parasite called *Coccidia*. Coccidiosis requires treatment with a different drug; speak to your veterinarian. Mismothered lambs found at docking/tailing show improved survival and growth to weaning if removed from the other ewes and lambs and offered very high-quality forage.

Drenching lambs between docking/tailing and weaning

Whether or not a preweaning drench is needed, depends on a number of factors.

If ewes have lambed in good condition, milked well and there's plenty of legume-dominant pasture on offer so that ewes and lambs are not in competition with each other for quality feed, a pre-weaning drench will likely be of little benefit. Arguably, all ewe flock managers should be focused on creating this outcome every year, as it is a key driver of heavy weaning weights in lambs and good body condition in ewes, both of which reduce drench dependence in a sheep breeding system.

However, if it has been a tight season for feed or ewes lambed in light condition and have not milked well, then a pre-weaning drench may help reduce some of the parasite-related effects on lamb growth prior to weaning.

Faecal egg counting of lambs pre-weaning can help determine whether a drench is required. There can be big variations between farms in pre-weaning faecal egg count of lambs. Feed levels from pre-lamb onwards, ewe condition, milk production, and legume content of pasture can be considered with the FEC information to help decide whether to drench.

Lamb faeces are generally easy to distinguish from those of ewes. They are typically smaller, more pelleted, and may contain tapeworm segments.

Regional variations in parasite species may influence preweaning drench decisions, such as *Nematodirus* in Southland and *Haemonchus* in the top half of the country.

Drenching lambs for tapeworm

Many New Zealand farmers choose their early-season lamb drenches based on a desire to remove tapeworms from lambs. Reasons are a belief that lambs will grow better, and that they will have less dags and be less attractive to flies.

Few farmers have ever treated half their lambs with a tapeworm drench and the other half with an ordinary worm drench at the same time to properly compare the two. Thus, any benefits seen are typically those observed between seasons. As seasonal variations in pasture growth, climatic conditions and ewe body condition can be substantial, comparing the effect of changes in drench policies or choices between years is fraught. It is likely that any perceived improvement from using drenches that include a tapeworm treatment, is due to the concurrent removal of the nematode parasites.

The majority of published trial work does not support a growth response to tapeworm treatment, and the effect of tapeworm treatment on dags has not been well studied.

Whilst the nematodes feed by physically browsing the gut edges (or sucking blood in the case of Barber's Pole worm), tapeworms absorb their nutrition through their skin. The head piece attaches to the intestinal wall more as an anchor. Thus, they are far less irritant to the gut than the nematodes.

One published New Zealand trial (sponsored by Ancare NZ) found a 36g/day advantage in drenching lambs with a praziquantel/levamisole combination versus straight levamisole. Other trials using praziquantel have not produced comparable results. A 1986 review of world literature concluded that there was no evidence of a production benefit from treating with any of the tapeworm – specific drugs that were available before praziquantel.

As long ago as 2004, New Zealand reports of tapeworm that had become resistant to praziquantel were published. In this work, the efficacy of Praziquantel and Albendazole against tapeworm in slaughter studies were similar, with both removing only 50-60% of the tapeworms present in the treated lambs.

Veterinarians performing routine post-drench faecal egg counts have noted that the presence of tapeworm eggs in lambs treated with praziquantel is becoming more common, although no national data is available.

In the face of increasing levels of drench resistance on New Zealand sheep farms, it is important that early season drench choices are made on the basis of known efficacy against nematodes, not on treating lambs for tapeworm.

Rumen bypass in lambs

Rumen bypass can be an issue in young lambs and can render a drench less effective than it should be. Drench is designed to be swallowed into the rumen, from where it is absorbed into the bloodstream and secreted back into the gut. Rumen bypass occurs when drench is delivered into the mouth and not over the back of the tongue. Liquid in the mouth triggers the lambs suckle reflex, diverting the drench straight into the abomasum (as would occur with milk).

Drench is absorbed into the bloodstream much faster from the abomasum and hence may not be in contact with the worms for long enough to give an effective kill. Use of low volume drenches can help prevent rumen bypass from occurring, but care must be taken not to overdose with products containing levamisole or abamectin, which have a narrow safety margin.

The best prevention for rumen bypass with standard drenches is to take your time with drenching and make sure the gun is passed right down over the back of the tongue, so the dose goes straight down the lamb's throat and not into the front of its mouth.

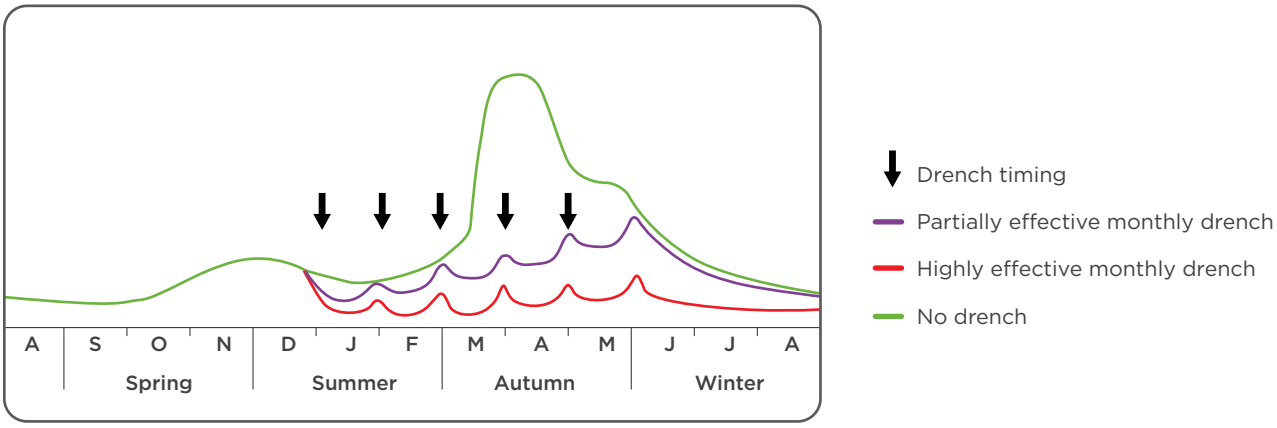
Drenching lambs from weaning

Preventative lamb drenching has traditionally been a programme of four or five drenches given at four-weekly intervals starting at weaning. For many lambs, the weaning treatment will have been their first drench.

The aim of the standard four-weekly preventative programme was to reduce pasture larval contamination, as seen in the diagram below. However, in the face of escalating drench resistance on New Zealand farms, it is important now to introduce as many other methods as possible to minimise summer and autumn pasture contamination caused by young animals, rather than simply relying on 4-weekly drenching of young stock.

Continued use of partially effective drenches at 4-weekly intervals, especially if other classes of stock are not sharing the grazing area with the young, drenched stock, results in an autumn build-up of resistant worm larvae on pasture. Simply changing from using older, ineffective drench products, to newer ones, and using them in the same way, is rapidly leading to resistance in some worm species.

Infective larvae on lamb pasture in a summer dry environment



Preventative drenching offered the advantage of being an easy programme to follow but now needs to be carefully considered alongside the threat that failing drenches pose to performance and profitability.

An alternative to preventative drenching is to provide young animals with forages/grazing that has been set up to offer a lower level of worm challenge. Then treat when monitoring indicates that it is necessary, rather than treating all animals in a mob at a calendar date. The most common approach to treatment of animals on low contamination grazing is to extend drench intervals, with FECs and other monitoring used to determine when treatment might be necessary.

Another approach is to maintain regular drench intervals and use targeted selective treatment (TST, chapter 5 page 32) to leave a proportion of the best performing animals undrenched, as a means of providing refugia in the low contamination area.

Which method is most suitable depends on the farm system, resources available and individual preference.

See chapter 5 – Refugia, for more details.

Drenching lambs in winter

As lambs mature, so does their immunity to worms. Big, well grown lambs are often able to be left undrenched for longer periods from late autumn onwards, some from even earlier than this (especially those that have been selected for early development of worm immunity). Faecal egg count information, liveweight gain performance and body condition can be used to assess if it is safe to leave animals untreated.

Winter finishing lambs on low worm contamination grazing may need no further treatment after their initial quarantine treatment.

Lambs suffering from other diseases such as facial eczema or pneumonia, can take much longer to develop their own immunity to worms.

Drench product choice in lambs

It is no longer possible or appropriate to give recipes on drench product choice.

However, the following guidelines apply:

- Combination drenches are generally preferred over single actives as they typically have a greater chance of removing more worms with resistant genotypes.
- However, you MUST NOT assume that because a drench is a combination of different actives, that it will be effective.
- Use drenches known to be highly effective on your farm, established by regular drench efficacy checks using faecal egg counts, throughout the season. A faecal egg count reduction test is a very useful start point but must be followed up with regular drench efficacy checks.
- There may be times where the chosen drench product is known to be one that has reduced efficacy against a certain worm species – if knowingly doing this, it is important to have a mitigation strategy to avoid the build-up of resistant worm progeny. Examples could include using the product at a time of the year where the resistant worm type is present in low numbers or using a leader-follower grazing strategy where another class of livestock 'cleans up' behind the treated youngstock.
- It is very important to avoid repeated use of products known to be of reduced efficacy.

Drenching calves

Young cattle are susceptible to the production-limiting effects of worms in the same way as lambs. However, the need for regular drenching of calves is more variable, depending on the production system. Artificially reared dairy or dairy beef calves are weaned off milk at a young age and are more fragile with regard to worms than their bigger and older counterparts being weaned off cows in the autumn. Depending on how they are fed and managed, artificially reared calves generally require more drench treatments in their first year than beef weaners.

Dairy and dairy-beef calves

Timing of first drench

These may be weaned off milk at less than 100kg liveweight. The smaller and younger they are when weaned, the more important it is that they receive very high-quality feed, close observation and regular worm monitoring, including drenching when required.

The same principles apply as for lambs. Drench is not required until after calves are functioning ruminants. They need to have been grazing pasture for enough time to have picked up sufficient L3 larvae to have a drench-responsive worm burden. Calves with access to starter meal and hay can show effective rumen function by 5-6 weeks of age. Depending on how calves have been managed, their intake of infective L3 from pasture will vary. Regular monitoring of faecal egg counts after 3 weeks at pasture is an excellent way to track worm burden in calves and drive decision-making around timing of their first drench.

Calves being grazed on high residuals of quality, low worm contamination pasture with ongoing access to meal may take many weeks after being turned onto pasture to develop a worm burden. Whereas those grazing short grass in highly contaminated calf paddocks may require drenching sooner. The latter situation is going to become untenable as drench resistance progresses in cattle, and calf-rearers would do well to think about how they might reduce contamination in calf paddocks between seasons.

Calves scouring in their early weeks of life are typically suffering from some other disease, or for nutritional reasons related to the milk feeding system.

Ongoing treatment of dairy and dairy beef calves

As for lambs, a simple 'recipe' of regular preventive drenches, while convenient, is likely to favour the build-up of resistant worms on pasture in calf grazing systems. Monthly drenching only leaves 1 week in every four where non-drench resistant worm eggs may be deposited onto pasture, as it takes at least 3 weeks for any new worms that establish after the drench, to be able to reproduce.

If using injectable or pour-on products, monthly treatments may leave no time for susceptible genotypes to reproduce at all, as these products typically have some persistency in the animals' body, and continue to prevent establishment of non-resistant worms for anything from a few days to several weeks.

Drenching must therefore be combined with other mitigations to provide calves with lower contamination feed, clean up behind them and provide refugia to dilute out resistant worms.

Forage crops, new grasses, pasture previously grazed by older cattle or sheep, grazing high pasture residuals and continuing to feed supplement are all means that can be used to reduce L3 intake by calves.

Extending drench intervals (underpinned by monitoring) and use of Targeted Selective Treatment (TST) can both be effective ways of maintaining worms in refugia. Some farms with very good feeding and stockmanship may be able to implement these approaches in quite young calves. On other farms it may be safer to wait till calves are older and bigger.

If extending drench intervals or leaving individuals untreated in a TST programme (see the TST section in Chapter 5, Refugia), start cautiously.

In the extended drench interval example, try extending the drench by one week, rather than several, and take a FEC sample on the day of drenching. If the FECs were low, it may give some confidence to push the following drench out by another week. If the FECs have risen sharply, it is a sign that the contamination of the grazing area is higher than ideal and should be addressed.

In the TST example, start by leaving a fairly small percentage of animals untreated, and identify them visually so that it is easy to track their performance. As for the extended drench example, if the untreated calves' performance drops off sharply, pasture contamination is probably too high.

Drenching of calves in winter

As calves mature, so does their immunity to worms. Big, well grown calves will often be able to be left undrenched for longer periods from 5-6 months onwards.

Faecal egg count information can start to become an unreliable indicator of the need for drench in calves between 6 and 9 months of age. Although a high FEC is indicative of infection, animals with a low or moderate FEC can sometimes still have a drench-responsive worm burden, especially if dominated by *Ostertagia*, which is a low egg producer. Liveweight gain performance and body condition become more important in assessing when and which calves are safe to leave untreated.

Calves wintered on forage crops would typically be treated on introduction to the crop, or after their transition period has finished. It is vital to check faecal egg counts at 28 days to ensure that no unexpected worm challenge has occurred while calves have been grazing the crop. This is especially true for crops with grass weeds present or grassy margins.

Product choices for calves

The guidelines for product choices in lambs apply, with one extra consideration for calves: route of administration.

While pour-on and injectable formulations are popular ways to administer drench to calves, both have been shown to be less effective than oral formulations against drug-resistant *Cooperia* in New Zealand. This parasite is particularly prevalent in calves in their first summer and autumn but can still form a large percentage of the worm population in R2 cattle as well.

It is recommended to use oral combination products for treating calves in their first year of life.

Ostertagia tends to become more of a threat as cattle approach their first winter. Historically, 'Mectin drench products have been more effective against *Ostertagia* than the Benzimidazole and Levamisole products and it is recommended that combination treatments for calves should contain a 'Mectin component from late autumn onwards if they have not already been in use over the summer.

However, like all drench recommendations, this efficacy should not be taken as a given, and regular drench performance monitoring should occur throughout the season.

Ostertagia is the bigger threat to cattle over 1 year of age, and on some farms, *Trichostrongylus axei* can also form a significant part of the worm burden up to about 2 years of age.

'Mectin drenches given via the injectable route achieve higher blood levels of drug, as well as higher concentrations of drugs into *Ostertagia* worms. *Ostertagia* are often closely associated with the lining of the abomasum and can even burrow into it, meaning they are very close to the blood vessels.

It is recommended that drench treatments to cattle over a year of age be given via the injectable route.

In general, pour-on formulations have the lowest and most variable absorption and are not recommended.

Cow-reared calves

Calves reared on cows and weaned at 5 or 6 months of age have typically passed through some of their most susceptible months to worm infection by the time they are weaned.

Weaning weight is important however and calves weaned early and/or at light weights can be more susceptible to worms.

A drench at weaning would be recommended in nearly all situations. The timing of follow up drenches depends on age and size at weaning, and worm contamination and quality of feed on offer after weaning.

Recommendations for drench choices in beef calves are the same as those for dairy beef (above).

Drenching adult sheep

As a general rule, adult sheep should not need drenching. Farm systems where adult sheep need regular treatment to maintain health and productivity should be re-evaluated to provide better nutrition to the breeding flock, reduce contamination from young stock, and review the genetics and overall stocking policies.

However, even within well-managed flocks there can be circumstances where drenching of some adults may bring production or animal health and welfare benefits. Factors which could influence the need to drench include ewe condition, feed availability and ewes carrying multiple lambs.

Two tooth ewes can be more susceptible to parasitism. Pinch points can be during lactation and in autumn, in situations where pasture contamination is high.

Mature ewes of fine wool breeds can appear to be more like two tooths in their susceptibility to worms, although their grazing behaviour and the type of feed they are offered may be major contributing factors to this observed higher susceptibility.

Pre-lamb drenching of ewes

Pre-lamb drenching of ewes has produced variable production responses in published trial work. In general, production responses have mostly been reported to long-acting treatments.

A summary of results from work in this area completed by AgResearch and others indicates:

- Extra weight (1-3kg) on ewes at weaning was quite repeatable
- Extra lamb liveweight at weaning was found about half of the time
- Lamb survival in treated ewe groups is highly variable; long-acting treatments did not improve lamb survival
- Weight of lamb weaned per hectare was not increased by long-acting treatments.

Use of long-acting products in ewes in systems where ewes and lambs share the grazing area after weaning is an established risk factor for drench resistance. This has been determined by long-term farmlet studies, results of the 2006 national drench resistance survey, and modelling studies.

Ewes with genetics selected for low faecal egg counts maintain a lower peri-parturient rise in faecal egg counts than ewes that have not been selected for worm resistance. Genetics is an important tool in the toolbox for reducing drench inputs into ewe flocks.

Drenching ewes at docking/tailing

Whole-flock ewe drenching at docking/tailing has been shown to increase the rate of development of drench resistance.

However, there may be times where drenching individuals or part mobs on the basis of body condition, scouring or poor feed availability is warranted. This approach may help younger ewes in particular (lactating hoggets and two tooths), who have a less robust immunity to worms than mixed age ewes.

Drenching ewes at weaning

Ideally, no ewes would be drenched at weaning. Undrenched ewes are a good source of refugia if integrated into lamb grazing rotations. Well fed, healthy ewes can also be net removers of worm larvae from the paddocks they are grazing.

If light mixed age ewes are drenched at weaning, they should be identified and culled if they do not re-gain condition within 1-2 months.

A useful alternative can be to draft off light ewes and add them to lamb mobs undrenched. They become a source of refugia within the lamb mob, whilst having the maximum chance of re-gaining lost weight from being offered high quality lamb feed. Alternatively, undrenched light ewes can follow lambs in a rotation.

Hoggets that have reared a lamb are more susceptible to worms than mixed age ewes. Drenching light hoggets at weaning can often help them re-gain condition, although these hoggets are also another good option to integrate into lamb grazing systems for refugia, if undrenched.

Drenching ewes prior to mating

Haemonchus (Barber's Pole worm) challenge over the mating period can affect ewe reproductive performance, and some farmers will drench ewes pre-mating to avoid this issue.

Ideally, a whole-flock treatment would be avoided, to enable some of the ewe flock to still be utilised as providers of refugia in lamb grazing areas, where relevant. A split-flock approach to monitoring and management can avoid the need for whole-flock (or indeed, any) drenching pre-tup in areas where Barber's Pole worm is a risk.

It is normal for two-tooth ewes and light conditioned mixed age ewes to have higher faecal egg counts and a higher percentage of Barber's Pole worm larvae in cultures, than their mature, well-conditioned counterparts.

A logical approach is to undertake FECs and parasite speciation on these three separate ewe groups in the weeks immediately prior to ram joining date, and make treatment decisions based on this data, as well as overall ewe condition, feed levels and climatic conditions.

Worm-resistant genetics are a long-term solution to worm challenge in ewes over mating time.

Drenching of rams

Rams typically live in small mobs for much of the year and thus do not face the same mob pressure as ewes. However, it is typical for them to live in small paddocks which can become short of feed at times, and not unusual for them to be 'forgotten about' for a period while other jobs are happening on the farm. Thus, finding adult rams in light condition is quite common. Individual rams may benefit from a drench to help them regain condition.

Rams without worm resistant genetics (especially terminal breeds which have generally not been selected for this trait) can be susceptible to Barber's Pole worm challenge over the mating period. A drench containing closantel or Moxidectin can help protect these susceptible rams over the mating period.

Ensure you use a product or combination of products known to be effective on your farm, if treating rams. Their performance is key to the success of next year's lamb crop, so if they are to be treated, doing the job properly is important.

Maternal rams with worm-resistant genetics should not require drenching and will contribute their worm-resistant genes to the next generation of ewe lambs.

Liver fluke treatments in sheep

Many areas of New Zealand have climatic conditions that are favourable for the survival of the snails that carry the infective stage of liver fluke, but not all farms in these districts have problems with liver fluke.

A liver fluke management plan should include strategies to minimise grazing of susceptible stock close to waterways and swamps. All ages of sheep are susceptible; unlike gut worms, adult sheep are not known to develop substantial immunity to fluke. Sheep will avoid grazing into waterways and swampy areas if given the choice – feed planning and good nutrition are important tools.

Do not embark on a fluke treatment programme unless you have established that fluke is genuinely a problem on your property. Post-mortem examination of tail end ewes in early winter is a great place to start. If these ewes are not carrying fluke, it is highly unlikely that liver fluke is present in enough numbers to warrant treatment.

There are 3 anthelmintics currently registered for sheep in New Zealand that treat fluke:

- Triclabendazole: Kills all stages of fluke
- Closantel: Kills fluke from 8 weeks of age
- Albendazole: Kills fluke from 12 weeks of age

How many fluke treatments are required on a property and the timing of these will vary depending on the farm and it's management (access of sheep to waterways/swamps and grazing pressure), and climatic conditions.

In areas with cold winters, fluke activity ceases over winter. A treatment of sheep in early winter may suffice, after which no further fluke infection is acquired from pasture until the next season. In areas with relatively warm winters, the fluke life cycle may not stop during winter, and an additional late winter or spring fluke treatment may be required to remove fluke infection accumulated over winter. In areas with very high fluke challenge, and sometimes after droughts, where sheep having been grazing down hard into swampy areas, an early autumn treatment may also be required to remove fluke that have already accumulated.

It is important to avoid constant use of the same chemical to treat fluke, to avoid resistance. Triclabendazole-resistant fluke have been diagnosed on at least one property in New Zealand and are common overseas. As for gut worms, management strategies to reduce the exposure of susceptible stock to fluke, are extremely important.

Drenching adult cattle

Cattle between 1 and 2 years of age

Immunity to worms in young cattle begins to develop from around 6 months old and progressively improves until somewhere between one and two years of age, where cattle become quite resistant to re-infection with worms. The majority of well-conditioned, well-fed animals will then carry relatively few worms in their gut and be largely unaffected by the worm larvae that they take in whilst grazing.

Drenching of yearling cattle coming out of a winter grass rotation, or after a few weeks on grass for animals coming off crop or silage wintering, can be good insurance to remove any *Ostertagia* that have accumulated in the abomasum through this time. An injectable combination drench containing a mectin drug is an ideal choice for this treatment.

Beyond this first post-winter treatment, drenching of cattle in the 1-to-2-year age bracket can then be confined to re-treating individual animals that are not achieving their liveweight targets and/or that are visually poorer than the rest of the mob. Approaching worm treatments for this age group in this way allows a useful percentage of animals to be left untreated and continue to provide some level of refugia in their grazing area. The untreated animals are able to contribute a low number of non-drench-resistant parasites back to the pasture, to help 'dilute out' the progeny of any resistant parasites that have been left behind in the treated animals or from calves grazing the same area.

Faecal egg counting is not a particularly useful tool in this age group as animals with a production-limiting worm burden may have low egg counts. Serum pepsinogen is a test that your veterinarian can request from blood samples, to assess the level of damage to the gut lining caused by *Ostertagia*. This information can help with drench decision making, but the test is not widely used.

First calving heifers

The discussion above on 1- to 2-year-old cattle also applies to first calving heifers.

Adult cattle

Typically, adult cattle should not need drenching.

Beef breeding systems are generally low risk, especially if adults outnumber young stock, and especially if the beef operation is part of a mixed system with sheep and/or deer.

There can however be circumstances where individuals may benefit from treatment. Light, young cows and very light mature cows after a drought or other periods of underfeeding may have a drench-responsive worm burden. *Ostertagia* is the main concern in these animals - an injectable drench containing a mectin is the treatment of choice.

In adult dairy cows, a drench in the dry period or early lactation is a common input on many farms. However, production responses from treating adult cows for worms are not a given, and no New Zealand trial work has shown a reproductive benefit to treating adult dairy cows.

Data from the small number of studies investigating milk production responses to drenching of New Zealand cows shows a positive response overall but with very wide variation between response in individual cows and between herds.

Risk factors include cows sharing the grazing area with calves, regular summer rainfall or irrigation, and underfeeding. First lactation heifers are more susceptible to worms than their mature counterparts.

Whole-herd anthelmintic treatment should generally not be necessary. At most, treatment of light conditioned mature cows, and young cows is likely to be warranted. There is a milk antibody test available for *Ostertagia*, but New Zealand studies on this test have failed to demonstrate that it is a reliable guide for herd treatment.

Dairy cows requiring treatment for lice should be treated with a louse-specific product, rather than using a mectin pour-on.

Liver Fluke treatment in cattle

Many areas of New Zealand have climatic conditions that are favourable for the survival of the snails that carry the infective stage of liver fluke, but not all farms in these districts have problems with liver fluke.

A liver fluke management plan should include strategies to minimise grazing of susceptible stock close to waterways and swamps. Cattle often choose to graze in the wet, swampy areas favoured by the fluke snail, so the eggs are deposited in a suitable environment. Young cattle are more susceptible to fluke infection, older cattle develop some resistance, though this varies between individuals.

As cattle mature, a fibrotic reaction (scarring) in the liver reduces the establishment of new fluke and shortens the lifespan of the fluke already resident in the liver. Fluke scarring reported on cattle kill sheets at slaughter is often the result of this process, though there may be no fluke remaining.

Do not embark on a fluke treatment programme unless you have established that fluke is genuinely a problem in cattle on your property. For properties with sheep, post-mortem examination of tail end ewes in early winter is ideal; if these are not infected with fluke, it is highly unlikely that cattle on the property will be affected. On cattle-only properties, post-mortems of tail end animals, a blood test, and a fluke egg test are options. In addition, a recently developed faecal antigen ELISA test can now detect the presence of flukes in the bile ducts, even if eggs are not present in the faecal sample.

There are 4 anthelmintics currently registered for cattle in New Zealand that treat fluke:

- Triclabendazole: Kills all stages of fluke
- Nitroxynil: Kills fluke from 2 weeks of age
- Clorsulon: Kills fluke from 8 weeks of age
- Albendazole: Kills fluke from 12 weeks of age

How many fluke treatments are required on a property and the timing of these will vary depending on the farm and it's management (access of cattle to waterways/swamps and grazing pressure), and climatic conditions.

In areas with cold winters, fluke activity ceases over winter. A treatment of cattle in early winter may suffice, after which no further fluke infection is acquired from pasture until the next season. In areas with relatively warm winters, the fluke life cycle may not stop during winter, and an additional late winter or spring fluke treatment may be required to remove fluke infection accumulated over winter. In areas with very high fluke challenge, and sometimes after droughts, where cattle having been grazing down hard into swampy areas, an early autumn treatment may also be required to remove fluke that have already accumulated.

It is important to avoid constant use of the same chemical to treat fluke, to avoid resistance. Resistant fluke have been diagnosed in sheep on at least one property in New Zealand and are common overseas. As for gut worms, management strategies to reduce the exposure of susceptible stock to fluke, are extremely important.

Lungworm treatment in cattle

All broad-spectrum drenches should be able to remove lungworm in cattle, as long as resistance is not present. A number of the mectin drenches have some persistency against lungworm; they may prevent the re-establishment of lungworm for a period of time, up to 6 weeks in some cases. It is not known whether any drench resistance has developed in cattle lungworm in New Zealand, including reduced persistency of previously long-acting products.

Artificially-reared calves in their first summer are typically the most susceptible class of cattle, although outbreaks sometimes occur in other age groups and at other times of the year. Adequate management of gut worms normally gives good control of lungworm in cattle. Reduced immunity (via underfeeding or concurrent disease), or a sudden change from grazing with no lungworm challenge, to more highly contaminated grazing, can be risk factors. Regular stimulation of the immune system via low intakes of lungworm larvae, is necessary for cattle to retain their immunity.

Strategic Drenches

Exit drenching

An exit drench is a short acting anthelmintic given to animals treated with a long-acting drench, injection, or capsule, after the expected period of protection has expired. The exit drench must be fully effective on the farm and contain drench actives from different drench families to that of the long-acting product.

The purpose of an exit drench is to kill parasites that have survived the long-acting treatment. This ensures that these parasites will not continue to reproduce and contaminate pastures. However an exit drench does nothing to prevent contamination of pasture with resistant larvae prior to it having been administered.

Knockout drenching

Knockout drenching is the substitution of one routine lamb drench with a drench containing either monepantel or derquantel. Resistant parasites, which have survived and accumulated from the preceding drenches, are then 'knocked out' by the new active. Monepantel may be used as a 'knock-out' drench in calf systems, but Derquantel is not registered for cattle.

Knockout drenching has been shown to delay the onset of resistance to the existing routine drenches used. This works by reducing the period of reproductive advantage for resistant parasites.

The greatest benefit is seen when a knockout drench is given just as conditions become favourable for larval survival and development on pasture. The ideal timing for a knockout drench is often late summer/early autumn, to aid in reducing an autumn larval peak of resistant parasites on pasture.

Quarantine Drenching

The aim of quarantine treatment is to ensure that new stock arriving onto a property do not bring on any resistant worms with them.

If comprehensive and recent drench performance testing is available from the vendor, and indicates a better resistance status than the purchasing farm, a quarantine treatment may not be required.

An effective quarantine treatment should have the highest chance of removing drench resistant worms. Given that the New Zealand data indicates that triple combination resistant worms are common on both sheep and cattle properties, the quarantine should, at a minimum, contain either Derquantel (sheep) or Monepantel (sheep and cattle).

The quarantine *protocol* is as important as the quarantine product, since most anthelmintics do not kill eggs, and these take some time to pass out of the animal's gut, after drenching.

While a highly effective quarantine drench will kill the adult and immature worms in the gut within hours of dosing, it may take much longer for the eggs already laid to pass out of the animal. There will be resistant eggs still passing out in the faeces.

Many of those eggs will have passed through after 24 hours and this is a reasonably practical period of time to keep new arrivals off pasture. After drenching, ideally hold new arrivals in a bare yard with supplementary feed and water available.

Animals could be dosed before they leave the vendor, so that part of the 'stand-off' time is done on the truck. Trucking is a stressful event for stock, and they tend to defecate more regularly during transport; this may help aid the removal of worm eggs after treatment.

Where a bare standoff area is not available, a carefully managed quarantine paddock could be used. It is important that this paddock is not then repeatedly grazed by animals that can allow resistant larvae developing from imported eggs to complete their life cycle. Thus, the quarantine paddock should not be grazed with the same species for many months. For instance, cattle are the only stock that graze a lamb quarantine paddock for 6 months. This system is easy to manage if new arrivals are only coming in over a short period. If new arrivals come in over a long period, there is a risk of creating a 'resistant worm hotspot' that will be harder to clean up, and where 'super-resistant' worms might arise.

Earmarking a quarantine paddock for immediate spray-out and cropping is another possible solution.

Quarantine treatment options

Sheep

Option 1 (Gold standard): Drenching with a combination of no less than four unrelated drench families, with at least one of these being the drench active monepantel or derquantel.

In practical terms, this means a drench with one combination drench containing monepantel plus abamectin or derquantel plus abamectin, followed by a drench with a benzimidazole (BZ) plus levamisole combination drench. Do not mix different drench products together.

This option provides the least risk for introduction of resistant worms, but requires more time, labour and cost. As possible interactions may occur between the individual drench actives when they are administered concurrently, approved meat withholding periods (WHP's) for the chosen products no longer apply. It is your responsibility to ensure that drug residues are not present at slaughter so ask your vet for advice regarding appropriate WHPs. If no information is available for the combination you have chosen, the default meat WHP of 91 days is applied.

Option 2 (compromise): Drench with a registered combination drench that must contain either monepantel or derquantel.

This option provides less protection against introduction of resistant worms; New Zealand laboratory data indicates that there are a small number of farms that have diagnosed worms surviving these products.

Time, labour and product costs are reduced, and the approved meat WHPs found on the product labels will apply. If you take this option, it is important to do a faecal egg count on the treated animals in 7-12 days, to ensure that no worm eggs are present.

Cattle

One of the novel drenches containing monepantel combined with abamectin is licensed for use in cattle. This is suitable for use as a quarantine drench, especially for calves coming from intensive calf rearers, or R1 cattle from similar high-risk situations. Care must be taken to accurately dose young calves to weight, to avoid toxicity.

If use of the monepantel plus abamectin product becomes more routine on cattle farms, concurrent use of this product with a BZ plus levamisole combination product will be recommended. Advice regarding concurrent administration of different drench products, discussed in Option 1 for sheep above, will apply.

R2 and older cattle typically have very low egg faecal egg counts and are unlikely to contribute high numbers of resistant worms to pasture after treatment. For this reason, it is generally recommended to treat R2 and older cattle on the basis of what they might need for their own health and production, versus a gold standard quarantine. Stressed, undergrown or sick R2 cattle may have higher egg counts – these may be passing more eggs – consider using Monepantel if bringing these in.

See the Wormwise website for further information on quarantine drenching: https://beeflambnz.com/knowledge-hub/blnz-wormwise-programme/drenching/quarantine-drenching

Drench families (Anthelmintics) and formulations

Drench is another name for Anthelmintic; 'Ant' (for anti-) 'Helminth' (a parasitic worm) - hence, Anthelmintic. An anthelmintic is a substance that kills parasitic worms when administered to livestock.

Once the animal has absorbed the anthelmintic from the gut, injection site, or through the skin (for pour-ons) the drug enters the blood stream and is circulated around the body. This blood-borne drug is then present in gut tissues and fluids, acting to kill worms. In the case of oral drenches, some drug will also remain in the gut contents without being absorbed into the bloodstream and can act directly on the worms in the gut fluid.

There are many anthelmintic drenches on the New Zealand market, with a bewildering array of different brand names. However, there are only a limited number of ingredients in these. By understanding the different categories described below and reading the product label, it is possible to make more informed decisions on product choice.

Drenches can be divided into their chemical families or action groups— each having a different effect on the target worms.

They can also be classified according to how many worm types they target (broad spectrum or narrow spectrum) and whether they are short or long-acting (persistent).

'Short acting' drenches may remain in the animal's body and continue to kill worms for 6-48 hours. Persistent or 'Long acting' drugs can remain in the body and kill worms for a variable period. This period of persistency may be as short as a few days, in the case of oral moxidectin against susceptible *Trichostrongylus* in sheep, or as long as 100 days for susceptible strains of parasites in sheep under treatment with a long-acting capsule. It is important to read the label – if a product has a persistency claim, it will be in the 'Indications' section. One of the first signs of resistance can be a shortening of the period of persistency, so never take a persistency claim at face value.

Broad spectrum drenches are effective against a wide range of different internal parasites, whereas narrow spectrum drenches kill a more limited range of parasites.

Broad Spectrum drenches

Broad spectrum drenches fall into one of five action groups: benzimidazoles, levamisole, macrocyclic lactones or 'mectins, amino-acetonitrile derivatives (AADs) and spiroindole (SI).

Resistance to the first 3 classes, and their combinations, is widespread. The descriptions that follow presume that the worms mentioned have not developed resistance to the drugs.

Benzimidazoles

Benzimidazoles, or BZs, are sometimes called 'white drenches' although not all are white. They act by preventing worms from absorbing nutrients, causing them to starve to death.

The BZs generally have broad spectrum activity against most susceptible worms in sheep and cattle, although activity against lungworm and inhibited worm larval stages may not be as good as the mectins. Albendazole also has some activity against liver fluke, while triclabendazole is only effective against liver fluke. The other BZs have no fluke activity.

Levamisole

Levamisole is sometimes called a 'clear drench'. Levamisole affects the worm's nervous system and paralyses it. Levamisole is effective against most worms, with the exception of inhibited L4 larvae of *Ostertagia* in cattle. This should be a consideration in the prevention of Type II ostertagiasis in cattle (refer to chapter 2). However, activity against inhibited *Teladorsagia* larvae in sheep is satisfactory.

Levamisole has a relatively low safety margin, do not over-dose.

Mectins

Mectin drenches, also called 'Macrocyclic lactones' (MLs) include avermectins and milbemycins. They are sometimes called endectocides as many have activity against both internal and external parasites. They work by paralysing the worm, but through a different mechanism than levamsiole. They are effective against most worms, including lungworm and inhibited larval stages in both sheep and cattle.

Some of the mectin drugs have persistent activity in the animal, meaning that the Mectin continues to kill ingested larvae for days or weeks following treatment.

Amino-acetonitrile derivatives (AAD)

Monepantel is the first member of this group of so called 'novel' actives. AADs act on a particular nicotinic acetylcholine receptor subunit (Hco-MPTL-1) that occurs only in nematodes and not in other organisms. Monepantel blocks these receptors and the affected worms are paralysed and die or are expelled. It is available as a double combination with abamectin.

Spiroindoles (SI)

The first member of this group is derquantel. Derquantel acts as a nicotinic cholinergic antagonist, by blocking the effect of acetylcholine; this causes flaccid paralysis and expulsion of worms from the gut. Derquantel is also known as a 'novel' active, although both derquantel and monepantel have been available in New Zealand since the late 2000's.

Derquantel has excellent efficacy against most significant nematodes in sheep. However, as a single active, derquantel has less than 95% efficacy against *Teladorsagia circumcincta* and some large bowel worms. Derquantel is available as a double combination with abamectin.

Combination drenches

Combination drenches were developed because of the emergence of single-active drench resistance. Combination drenches contain mixtures of different single active drugs formulated to deliver a standard dose of each component, in a stable product.

Worms resistant to one active ingredient were generally killed by one of the other drugs in the combination. The use of combinations was advocated as part of Wormwise's recommendations to help slow resistance, along with attention to minimising other risk factors.

The main benefit of combinations was to reduce the survival of drench-resistant genotypes in the worm populations on-farm.

However, without attention to other important factors such as reducing drench dependence and ensuring refugia, the widespread and intensive use of combinations has led to an upswing of resistance to these products.

All combination drench products in routine use in both sheep and cattle should be monitored regularly for effectiveness – see Chapter 6, Monitoring.

Narrow spectrum drenches

Narrow spectrum drenches include clorsulon, closantel and praziquantel, which are used for killing specific worms such as liver fluke or tapeworms. Closantel base has persistent activity against *Haemonchus* (barber's pole worm). Formulations containing closantel salt lack this persistent activity, check the label.

Drench groups and their active ingredients

Broad spectrum		Narrow spectrum	
Drench family	**Active ingredients**	**Drench family**	**Active ingredients (& target parasites)**
Benzimidazole	Albendazole, Oxfendazole, Fenbendazole, Mebendazole, Rycobendazole	Benzimidazole	Triclabendazole (liver fluke – all stages)
Levamisole	Levamisole	Benzoenedisulponamide	Clorsulon (liver fluke - adult)
Mectins	Ivermectin, Abamectin, Doramectin, Eprinomectin, Moxidectin	Salicylanilide	Closantel (liver fluke - adult, sustained activity v. *Haemonchus* as closantel base)
Monepantel	Monepantel	Nitrophenolic compounds	Nitroxynil (liver fluke, adult)
Spiroindole	Derquantel	Pyrazinoisoquinoline	

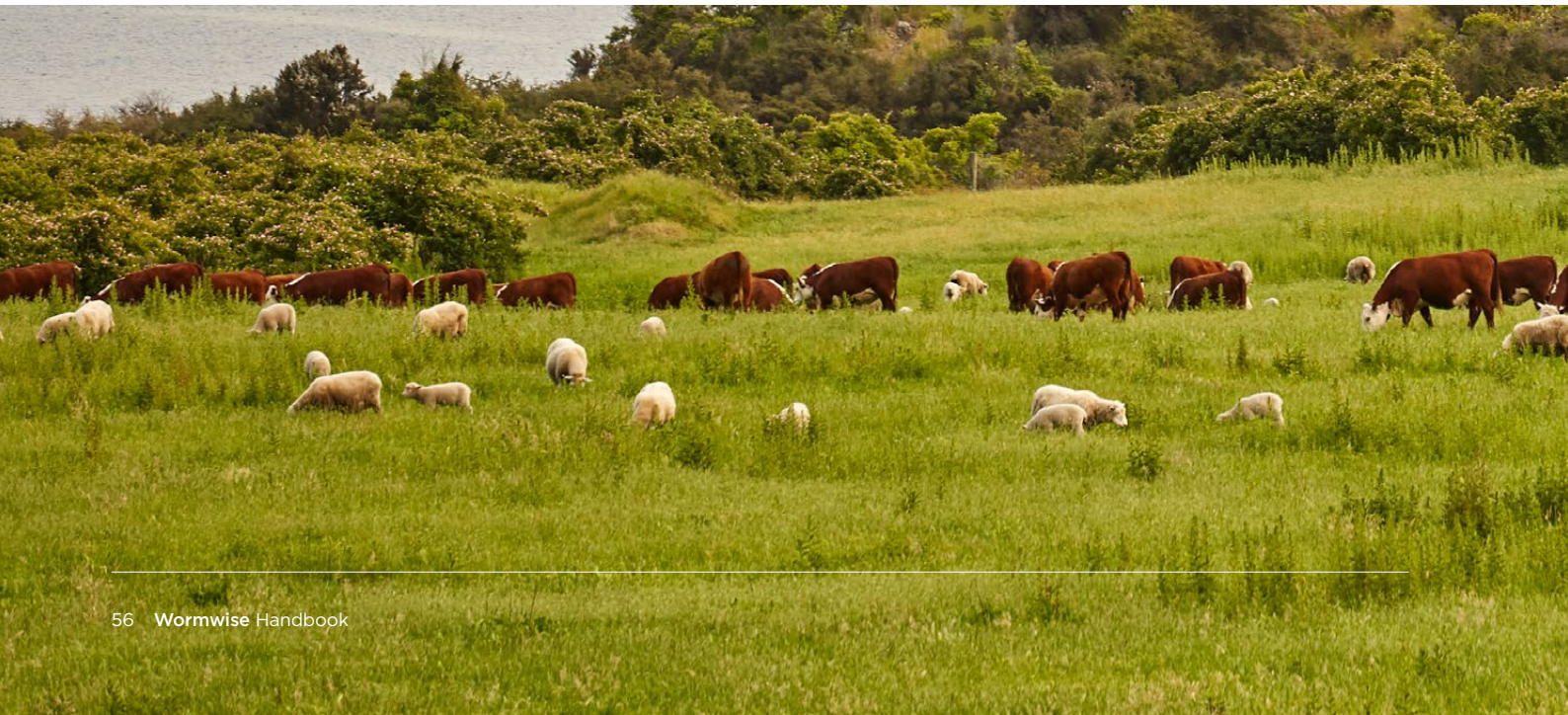
Formulations

Drenches can be administered to sheep and cattle by a variety of different methods. Drench formulation and method of administration can make a difference to drench efficacy and length of activity against different worm species as well as the withholding period. For this reason, it is important to read the label carefully and to follow the specific recommendations for each product.

Drench storage & handling and administration

Read the label carefully, check the following:

- Active ingredients
- Dose rate (ml/kg live weight)
- Withholding period
- Storage conditions.
- Handling, e.g. shake well before use
- Expiry date
- Safety precautions for operators



Drench administration:

- Do not under-dose. Weigh representative stock to ensure correct dose is given.
- Select a dose volume based on the bodyweight of the heaviest animals in the group, split group into weight lines if there is substantial variation, to avoid overdosing.
- Set and check the accuracy of the drench gun by squirting several doses into a calibrated measuring vessel, or into a clean container and then draw the liquid up with a syringe accurate to 0.5ml.
- Re-check the dose delivery each day the gun is used or after every 200 doses, whichever comes first.
- Ensure your drench gun receives regular maintenance.

See B+LNZ Wormwise's 'Drenchwise: Do it once, do it right' poster
https://beeflambnz.com/knowledge-hub/PDF/drenchwise-do-it-once-do-it-right.pdf
Contact resources@beeflambnz.com for copies of the 'Drenchwise' poster.

Drench resistance

Drench resistance is present when previously susceptible worm populations in the animal survive a correctly administered standard dose of anthelmintic or drench. The resistant worms do not die and continue breeding.

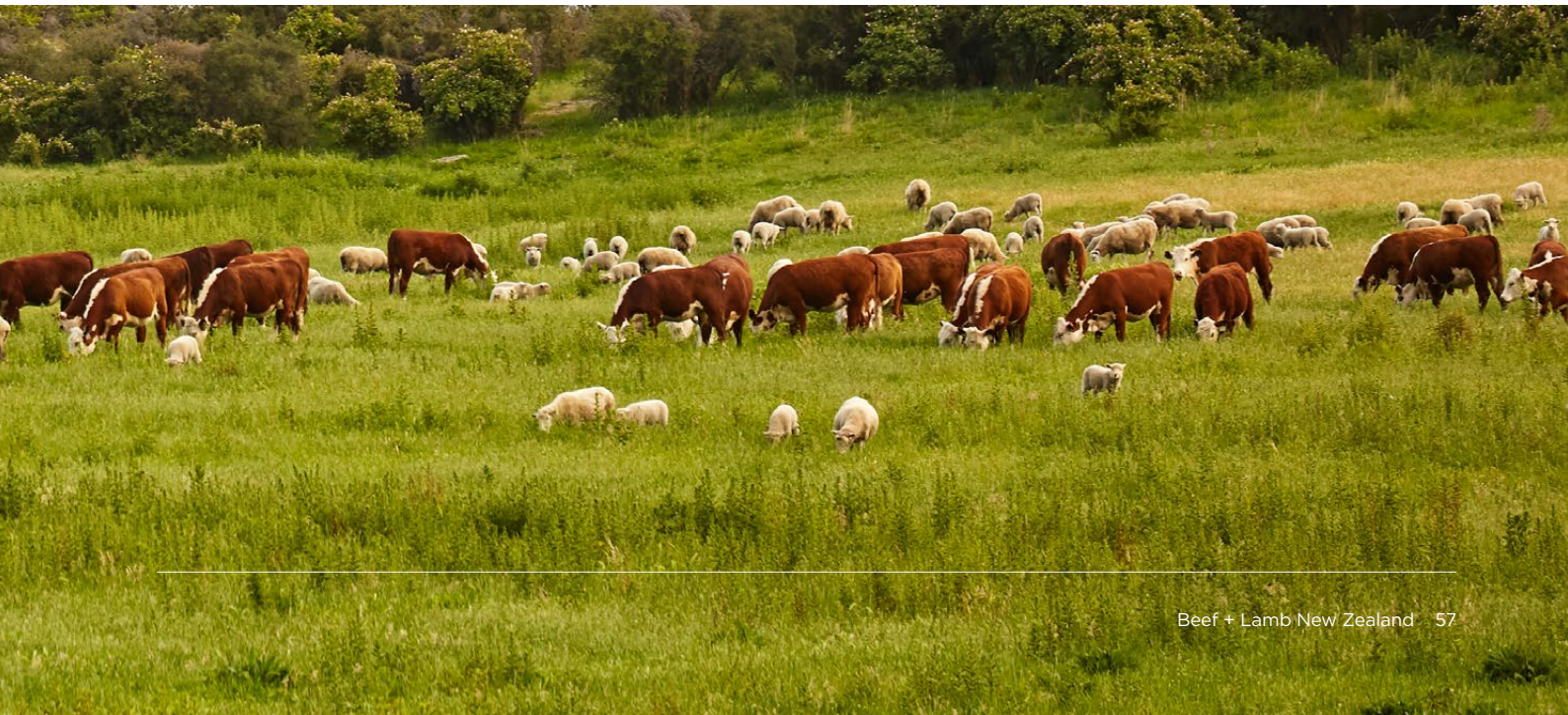
There will always be some worms with the genetic make-up to be able to survive a particular drug, even a brand new one. To begin with, these resistant worms will be present in tiny numbers, but over time, their progeny will breed with each other, passing on their resistant genes to their offspring, while non-resistant worms are killed. Thus, resistant worms make up an increasing proportion of the worm population on the farm.

This situation has manifested on New Zealand farms as a large upswing in cases of deaths and disease in lambs in the late summer and autumn from resistant *Trichostrongylus* and *Teladorsagia*, and in cases of sick and dying calves on intensive cattle blocks caused by resistant *Cooperia* and *Ostertagia*.

Drench resistance to single actives in sheep worms was reported in New Zealand in the early 1980's. A large-scale national survey reported in 2006 found that 64% of sheep farms and 92% of cattle farms had worms resistant to at least one drench family. Combinations were not widely tested in that survey, and at the time 8% of the sheep farms tested had worms that were resistant to a BZ/Levamisole combination.

Laboratory reports from 2022 onwards highlight an increasing number of sheep farms showing resistance to all combination drenches, in particular triple combinations. In 2025, Awanui Veterinary reported that 43% of faecal egg count reduction tests found *Trichostrongylus* to be resistant to a triple combination.

Worms resistant to one drench in an action family will be resistant, to a greater or lesser extent, to all other drenches in the same action family—this is called side resistance.



Drench resistance risk factors

Lack of refugia

On farms or blocks where drench is the main means of managing worm levels on pasture, eventually the drench-surviving worms start to outnumber the other worms. This point has been reached on some New Zealand farms, requiring system change.

Risk factors identified in previous research work and surveys that contribute to lack of refugia and eventual drench resistance include:

- Regular ewe drenching on breeding/finishing properties where ewes and lambs share the grazing area after weaning. This includes long-acting pre-lamb treatments and whole flock docking/tailing drenching. The effect of whole-flock pre-tup drenching has been less well studied but certainly reduces the ability of ewes to act as a source of refugia in the critical autumn period, so is likely a risk factor. Short acting drenches given to ewes immediately pre-lamb are likely to be less of a risk given the rapid potential for re-infection in at least some ewes over lambing.
- Preventive young stock drenching (especially if at 28 days or less) on lamb or calf only blocks.

Sheep systems where regular treatment of ewes is required for health and productivity, and lamb or calf only systems that are reliant entirely on drench to control worms, typically have high levels of larval contamination on pasture. If drenches are simply removed from these systems in the name of creating refugia, production and health of the animals is likely to suffer. Farm system change to reduce contamination is required.

Drenching onto 'clean' areas

'Clean' or low contamination areas on a farm include newly sown pasture, some crops, and areas that have grazed another species for several months (sheep or deer for calves, cattle or deer for lambs). Drenching lambs or calves onto "clean" pasture can select strongly for drench resistance, as the new population of larvae that forms on the clean area will be from worms that have survived the drench. The main way to slow drench resistance on these areas is to ensure that the new worm population establishing on the clean area is predominantly composed of susceptible worms.

For newly sown pasture, an ideal strategy is to do the first grazing with undrenched ewes or 2 tooths, rather than lambs that have been under a regular drench regime. This enables a small population of susceptible larvae to establish on the clean area.

Lambs or calves that are due (or even a bit 'overdue') for a drench are another option. However, depending on how many previous drenches they have had, the balance of worm eggs coming out of these could still be very much in favour of resistant worms.

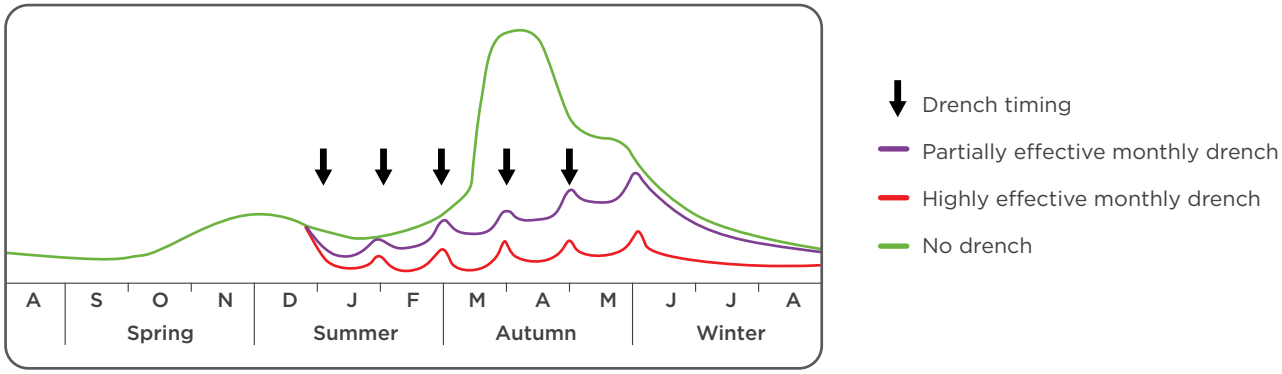
Where lambs or calves are grazing "clean" pasture the drenching interval can and should be extended. Regular preventive drenching on clean areas can be highly selective for drench resistance. Monitoring via faecal egg counts at 28 days is an excellent back-stop to ensure that the area truly is clean; if egg counts have risen substantially, animals can be treated, but the expectation would be that egg counts are low and that treatment is not required.

Continued use of an ineffective product

Where drench resistance is established on a farm, continued use of an ineffective product can rapidly increase the gene frequency of drench-resistant worms.

Regular drench checks (including larval cultures) throughout the season are the best way of monitoring drench efficacy in real time on a farm. See Chapter 6 – Monitoring – for more information.

Infective larvae on lamb pasture in a summer dry environment



It is not a given that combination products will be effective. The best time to start using combinations to delay resistance is when there is minimal resistance to the component actives. Most New Zealand farms are well beyond that point and drench choices should be based on a knowledge of what is effective on the farm, the worm species likely to be predominant in stock, and the risk to animals and the farm system of knowingly using drenches that only have partial efficacy. At times this risk may be less and a partially effective product may suffice. At others, the risk may be higher, and a more effective product is required. In all cases, working towards a farm system where drench is not the main means of limiting worm challenge, is crucial.

Underdosing is another way of making a drench less effective than it should be. Ensure that the guidelines for proper dosing on page 54 are followed, and ensure the route of administration chosen (e.g. oral, injection) is most appropriate for the stock class and type of worms you are targeting.

Organic production

Managing internal parasites in the absence of anthelmintics requires a thorough knowledge of worm biology and life cycles, and the effects of different environmental and management practices on worm challenge to stock.

A significant change in stocking and pasture management policies is necessary. Young animals must be managed on high grazing residuals and low worm challenge feed, and breeding stock must be well fed to enable no anthelmintic input.

A high level of monitoring of FECs, feed levels, behaviour and general appearance of stock is important to pre-empt unexpected parasite challenges. Monitoring growth rates, body condition and other performance indictors is important to ensure that the management plan is on track. Swift removal and preferential management of non-performers from mobs is vital.

Currently, no organic drenches reach the threshold for registration as veterinary medicines under the ACVM Act (clinical trial data showing greater than 95% efficacy against particular worm species). As such any potential benefits are more likely to accrue from a holistic effect of the product on the treated animal. For animal welfare reasons some organic protocols allow limited use of certain chemical drench actives. The current protocol for the use of these should always be checked with the organic certification agency prior to use.

Bibliography

Southworth, J., Harvey, C., & Larson, S. Use of praziquantel for the control of *Moniezia expansa* in lambs. New Zealand Veterinary Journal 1996, 44, 112–115.

Mason P, Moffat J, Cole D (2002). Tapeworm in sheep revisited. Proceedings of the 32nd Seminar of The Society of Sheep & Beef Cattle Veterinarians, 2002. 147-151.

B+LNZ Final project report: 'SmartWorm® App Pilot Study'
https://beeflambnz.com/knowledge-hub/PDF/smartwormr-app-pilot-study.pdf

B+LNZ Final project report: 'SmartWorm® App - Case Studies'
https://beeflambnz.com/knowledge-hub/PDF/smartwormr-app-case-studies.pdf

Miller C, Ganesh S, Garland CB & Leathwick D. Production benefits from pre- and post lambing anthelmintic treatment of ewes on commercial farms in the southern North Island of New Zealand, New Zealand Veterinary Journal, 2015.

Barger, I. Influence of sex and reproductive status on susceptibility of ruminants to nematode parasitism. International Journal for Parasitology, Volume 23, Issue 4, July 1993, Pages 463-469.

Leslie J, Westwood C. Forage crops – it's not only about gross margin. Proceedings of the Sheep and Beef Cattle Veterinarians and the Deer Veterinarians Branches of the NZVA, Volume 2025 Proceedings, pp 1-4, Jun 2025.

Niezen J. The effect of forages on lamb parasitism and performance. Proceedings of the Sheep and Beef Cattle Veterinarians and the Deer Veterinarians Branches of the NZVA, Volume 2025 Proceedings, pp 5-8, Jun 2025.

Liver fluke disease in sheep and cattle, by J Boray (March 2007) NSW DPI Primefact 446.

Chapman V, Hassell C, Orbell G, Pomroy W. Resistance to triclabendazole in *Fasciola hepatica* on a commercial sheep farm in Taranaki, New Zealand. N Z Vet J. Vol 29, pp1-5, Jan 2026.

Notes

beef+lamb new zealand

wormwise

Funded by Beef + Lamb New Zealand

Think Wormwise, think

F.A.R.M.ED