Control of roundworms in cattle

This document is part of the COWS Technical Manual which aims to provide a sound basis for advice to the industry.

The manual also comprises chapters on controlling lungworm, liver and rumen fluke, ectoparasites and integrated parasite control.

COWS
Control Of Worms Sustainably

COWS is an industry initiative promoting sustainable control strategies for parasites in cattle

With thanks to Professor Eric Morgan, Queen's University Belfast for help and guidance in writing this COWS chapter.
Updated by Professor Diana Williams, University of Liverpool, August 2023

Section 1: Top tips for controlling roundworms (parasitic gastroenteritis or PGE) in cattle

Informed and sound preparation will minimise roundworm infection with positive effects on enterprise returns.

Identify risk

1. All grazing cattle are exposed to round/gut worms and consequently can suffer production losses. Younger cattle are most at risk of disease until they acquire immunity. The potential production loss increases with increasing parasite challenge
2. Permanent pastures that have been grazed by youngstock in the past 12 months present a high risk. The safest pastures are newly planted leys following a cereal or root crop. These are considered 'clean'
3. Larval worms accumulate on pasture over the grazing season and infective stages typically peak from mid-summer (July) onwards when the risk of disease is highest
4. If young cattle are not treated with an effective anthelmintic in the autumn, they may be at risk of disease in late winter

Treat appropriately

5. Anthelmintic treatments should be targeted at individuals or groups at appropriate times to ensure performance objectives are met. Specific diagnostic tests and monitoring of growth rates can help achieve this. Ask the vet or registered animal medicines adviser (RAMA) or suitably qualified person (SQP) for details
6. Effective anthelmintic treatment of first season grazing calves at housing can minimise the risk of worm disease at the end of winter, particularly if they have been grazed on pasture contaminated with parasite larvae. Ask the vet, RAMA or SQP if treatment is necessary and if it is, about the correct products to use at housing

Avoid resistance

7. Use anthelmintics correctly. Follow label instructions, weigh cattle if possible and avoid under-dosing. Check dosing equipment regularly to ensure the precise dose is delivered. Always store anthelmintics according to the manufacturers' recommendations
8. Anthelmintic resistance has been detected in *Cooperia* and *Ostertagia* intestinal worms in many countries including the UK. This must be treated as an early warning. It is essential that anthelmintics are used responsibly
9. There are many risk factors for anthelmintic resistance. The best ways of limiting selection pressure on worm populations is to avoid treating cattle unnecessarily and to ensure the correct drug and dose is used.

Section 2: Introduction to roundworms (nematodes), *Ostertagia ostertagi* and *Cooperia oncophora*

Introduction

Cattle can acquire infections with any of several species of roundworms when grazing pastures. The most common and important in northern Europe are *Ostertagia ostertagi*, which live in the abomasum, and *Cooperia oncophora*, which inhabit the small intestine.

These worms are ubiquitous and can be found on all cattle farms where animals have access to grassland, even when only for short periods.

Whilst these parasites are common, clinical disease

Key concerns

- Roundworms found on all cattle pastures
- Disease mostly seen in calves and young cattle
- Can reduce growth rates by 30%

(loss of appetite, scouring and poor condition), is generally only seen in young calves during their first grazing season, when control has been inadequate.

Infected animals can experience a loss of production, which may be economically important but can be difficult to detect without accurate observation and recording.

In youngstock, gastrointestinal parasitism can reduce growth rate by up to 30%, even with a low level of worm challenge. This makes it difficult to achieve growth targets for beef animals or replacement heifers.

Even in adult cows, which are likely to be more immune to worms than calves, infections can cause up to 1kg per day drop in daily milk yield.

Disease

Parasitic Gastritis (PG) (Ostertagiosis)

Ostertagia ostertagi develop in the gastric glands in the abomasum, where they damage both glandular tissue and surrounding cells.

A diseased abomasum is thickened and the parasitised glands can easily be seen on the inside surface of the stomach. This pathology has a number of knock-on effects, including reduced acidity of the stomach contents leading to disruption of protein digestion, a release of appetite suppressing compounds and a proliferation of gut bacteria which are normally inactivated by low (acid) pH. However, the most significant effect is loss of protein to the gut.

Parasitic Gastritis in young grazing cattle, typically seen in mid-summer, is also known as Type I ostertagiosis. Less commonly, disease can appear towards the end of the housing period and this is known as Type II ostertagiosis.

Parasitic Gastroenteritis (PGE) (*Cooperia oncophora* and *Ostertagia ostertagi*)

The pathology resulting from infections with *Cooperia oncophora* in the small intestine is much less obvious than that induced by *O. ostertagi* in the abomasum. However, there is still microscopic damage to the intestinal lining that can lead to poor digestion and absorption of nutrients.

The species of *Cooperia* found in the UK (*Cooperia oncophora*) is generally considered to be less pathogenic than the tropical species (*Cooperia punctata*).

Under normal field conditions, young cattle can be infected with both *Ostertagia* and *Cooperia* at the same time. There is some evidence for synergy between the species.

The damaged small intestine cannot compensate for the poor protein digestion and protein loss in the parasitised abomasum. The impact of dual infections is higher than either of them individually. Disease resulting from mixed infections with stomach and intestinal worms is called parasitic gastroenteritis (PGE).

Figure 1: *Ostertagia* lesions on abomasal mucosa.

Moredun Research Institute

Ostertagiosis Type II

This condition generally only affects a small proportion of animals in a group, but it can be serious and lead to death.

The cause is the simultaneous development and emergence of inhibited or arrested larvae, ingested at the end of the preceding grazing season. Instead of developing over the three weeks following ingestion, as normally happens earlier in the season, these larvae undergo a period of arrested development and lie dormant in the gastric glands as tiny, immature, fourth stage larvae (L_4).

The L_4 persist in the stomach wall for several months until a trigger, currently unknown, stimulates them to resume development, when they can cause extensive damage to the abomasum, leading to severe clinical signs in affected animals.

Signs of *O. ostertagi* infection

- Loss of appetite
- Loss of body weight and condition
- Diarrhoea

In severe infections, these changes in the gut can lead to the most obvious clinical sign, which is diarrhoea. Loss of nutrients and fluids is partially responsible for the loss of weight and body condition in affected animals. However, the greatest cause of ill-thrift is reduced feed intake, which can account for 60–70% of weight loss observed in young parasitised cattle.

Though not so marked, a loss of appetite also seems to explain much of the production loss observed in adult cattle infected with *O. ostertagi.*

Section 3: The parasite

Biology

Ostertagia ostertagi and *Cooperia oncophora* are members of a diverse class of worms called nematodes, commonly known as roundworms.

Parasitic nematodes are generally host-specific, so cattle nematodes rarely successfully infect sheep or other livestock. However, there are a few exceptions, such as *Nematodirus battus*, a sheep nematode which occasionally causes disease in calves.

Host specificity in worm species underpins the use of alternative or mixed grazing strategies to reduce the risk of heavy parasite burdens in livestock. Sheep can graze pastures infested with cattle nematode larvae, but these larvae will not develop within sheep. Thereafter the pasture will pose a much smaller risk to grazing cattle.

It should be noted that co-grazing may be inappropriate if parasites such as *Fasciola hepatica* (liver fluke) are present, as these readily infect both sheep and cattle (see the COWS liver fluke chapter). Similarly, some Herd Health Schemes recommend avoiding co-grazing with sheep to control transmission of Johnes Disease.

Life cycle

Adult parasitic roundworms of cattle are a few millimetres long and just visible to the naked eye if the abomasum or intestines of infected animals are examined post-mortem. Microscopy is needed to appreciate finer structures and to see immature larvae.

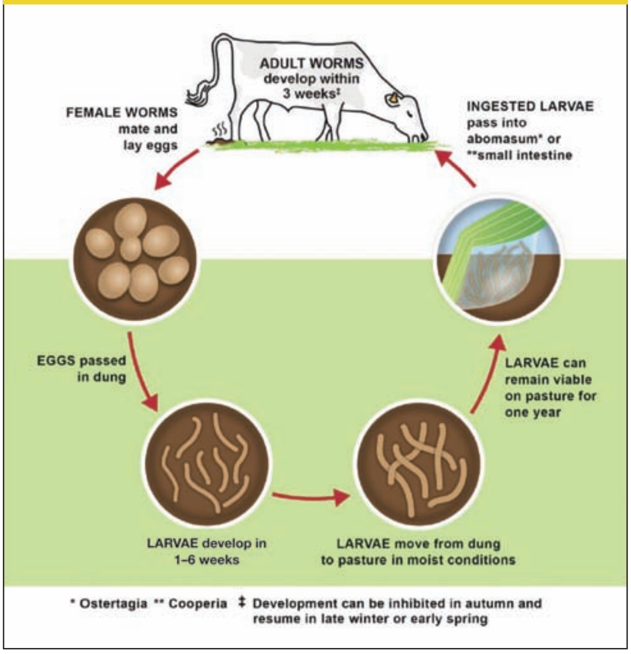
The life cycle of cattle parasitic nematodes is direct. No intermediate hosts are involved and transmission among animals is via infective larvae from pasture.

These worms do not have a migratory phase within the host. There are two sexes and mating is required between males and females for the latter to produce fertile eggs.

Figure 2: Adult female *Cooperia oncophora*.

Moredun Research Institute

Figure 3: Roundworm life cycle



Eggs are passed out in faeces. Given the right temperature and moisture conditions, the first stage larvae hatch out in dung. These larvae develop through two further stages, ultimately becoming the infective third stage larvae (L_3).

The rate of development is largely temperature-dependent providing adequate moisture is available in the pat. It can be completed within a week or less when the environmental temperatures are 15 to 23°C, and within three to six weeks at temperatures of around 10°C.

Rainfall is also important to enable infective larvae to leave the pat and make their way onto herbage, where they are more likely to be ingested by cattle.

Larvae have limited mobility but can migrate a few centimetres from faeces if conditions are moist. More important is the effect of rainfall, which softens the pat and raindrop splashes help disperse larvae over greater distances.

Infective L_3 larvae are protected by an outer sheath, which is the retained 'skin' of second stage larvae. This makes them relatively resilient and they can survive on pasture for many months – some for over a year under normal environmental conditions in the UK.

The L_3 are sensitive to desiccation, so larval survival is reduced during hot, dry spells of weather. However, larvae can shelter in soil and emerge again after rain. They survive particularly well in cool, damp conditions.

Grazing management for worm control is based on knowledge of when and how long it takes for infective larvae to appear on pasture and how long they survive. This information underpins strategies intended to limit exposure of grazing cattle to challenge.

When cattle ingest infective larvae, they pass to their preferential sites for development, the abomasum for *O. ostertagi* and the proximal small intestine for *Cooperia* spp.

During spring and summer when L_3 larvae are eaten, they establish in the gut of the cattle and develop into adult worms within about three weeks, at which time females start to lay eggs.

The interval between ingestion of larvae and appearance of worm eggs in dung is known as the pre-patent period. This is an important measurement, as it helps plan worm control programmes, particularly where the objective is to limit contamination of pasture with worm eggs.

Both *O. ostertagi* and *C. oncophora* can slow their development in the gut of cattle under some circumstances. Inhibition of larval *O. ostertagi* is an adaptation for survival over winter, but it can also result in disease.

The typical sequence of events is that when cattle are grazing in autumn, a high proportion of the larvae which are eaten, stop developing a few days after entering the abomasum. They remain dormant within the gastric glands causing very little damage. However, in late winter or early spring, something triggers them to resume development.

If the numbers of developing larvae are small, there may be few consequences for the host animal. However, if large numbers of larvae resume development and emerge as adults simultaneously, there is considerable damage to the abomasum with serious consequences known as Type II ostertagiosis.

Section 4: Immunity

Cattle acquire immunity when exposed to roundworms. However, it takes a relatively long time – roughly one full grazing season for *C. oncophora* and up to two grazing seasons for *O. ostertagi*. Even then, immunity is not complete. Cattle of all ages still have worms, particularly *O. ostertagi*, which can result in abomasal pathology.

Older cattle tend to have smaller burdens of adult worms than young cattle and lower faecal egg counts, rarely showing signs of clinical disease. However, they can incur production losses.

The rate immunity develops is a function of exposure to infective larvae. Functional immunity can develop even when anthelmintic treatments are given during their first grazing season. However, if young cattle have no exposure at all to pasture as calves, for example calves born in summer in year-round-calving dairy herds, then they should be considered parasite-naïve when they go out to grass the following year.

Acquiring immunity

- Can take up to two grazing seasons
- Immunity is never complete
- Only develops where cattle graze contaminated pasture

Calves that are over-protected in their first season at grass by excessive anthelmintic treatment are also at risk of slow development of immunity.

There is a balance between achieving enough exposure to stimulate immunity, but not so much as to cause abomasal damage.

For *Ostertagia*, plasma pepsinogen testing at housing indicates level of exposure during the first grazing season and can help guide the following year's strategy.

As a rule of thumb, cattle must be at grass for at least eight months on pasture that has been used for cattle in the previous year, to get enough exposure for immunity to develop.

This total time of effective contact (TEC), is likely to be split between two grazing seasons, and indicates the time when farmers can expect reasonable levels of immunity to be in place.

In reality, levels of exposure will be affected by other factors, including the effect of climate on development and survival of infective larvae.

Immune development is also influenced by host factors including age, sex, nutrition and potentially, genetics.

Poor development of immunity in replacement heifers, can lead to greater susceptibility in milking cows and the risk of production losses if they become exposed.

Paradoxically, herds in which this occurs tend to have high levels of detectable anti-nematode antibodies in the bulk milk. These herds are most likely to benefit from treatment of the milking cows.

At the same time, grazing and worm control procedures in replacement heifers should be reviewed, to improve the development of immunity and reduce the need to treat milking cows in future.

Section 5: Epidemiology

Most cattle in northern Europe are housed over winter and there is virtually no acquisition of new worm infections, as animals are not grazing and survival of larvae in hay and silage is generally poor.

Over winter there is limited and slow development of eggs and larvae in dung pats deposited before housing, due to low temperatures and many die. In this period there is also a gradual decline in the number of infective larvae found on pasture, as these stages do not feed and slowly use up their energy reserves. However, sufficient overwintered larvae survive to infect calves the following spring.

Survival of larvae declines more rapidly in spring because higher temperatures mean metabolism is faster. Consequently, larval energy reserves deplete more quickly and most will have died by early June.

Once cattle are turned out in spring, they can acquire infections by encountering residual over-wintered larval populations on pasture. Eggs are also shed from worms overwintering in the intestines of older cattle.

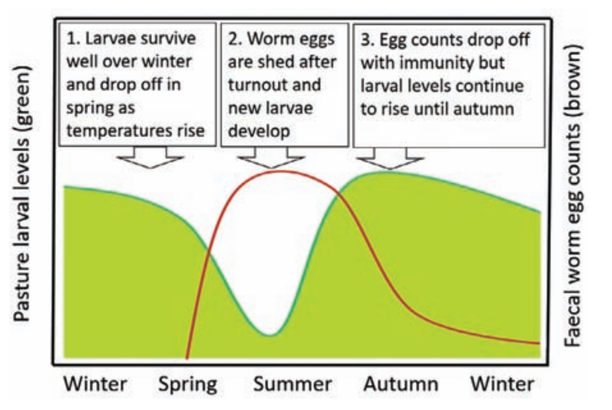
When weaned calves in their first grazing season with limited or no immunity ingest larvae, a high proportion of worms establish in the gut and develop to adults, which produce eggs.

Seasonal patterns of challenge are broadly similar with older cattle and in beef suckler herds. However,

Risk factors

- Cattle in the first grazing season have no immunity
- Adult worms shed eggs, leading to build-up of larvae on pastures
- Peak larvae numbers reached in late summer
- Exposure can be reduced using grazing strategies

Figure 4: Pasture larval levels and faecal worm egg counts for roundworms throughout the seasons



levels of infection are generally lower, as immune cattle have smaller worm populations that produce fewer eggs.

Fields not grazed early in the season and used for hay or silage production can be available for grazing from July/August onwards and are considered safe. As there has been no cycling of infection and over-wintered larval populations decline exponentially, the risk of cattle acquiring heavy worm burdens while grazing such paddocks is lessened. When cattle are zero-grazed, farmers must be aware of the grazing history of the grass being harvested.

Changes in weather, such as dry summers or mild autumns, can affect the level of larval challenge and consequently the risk of disease in cattle, as well as the development of immunity.

Dry summers are likely to slow down the accumulation of larvae on pastures, but this could rise rapidly following rainfall when larvae are released from cow pats.

Computer models have been developed to predict the effect of weather, grazing patterns and treatment on pasture larval levels and these can be used to support sound decisions under climate change. Meaningful risk forecasts cannot be made without information on grazing history.

Section 6: Control

The aims of control programmes for gastro-intestinal nematodes are to:

1. Prevent clinical disease
2. Prevent sub-clinical losses, particularly growth in youngstock and milk production in adult cattle
3. Develop immunity

Anthelmintics are an important part of different control programmes. However, many of the gastro-intestinal nematode species have developed resistance to anthelmintics, so these medicines must be used carefully.

Every farm is different and control measures that work on one farm may not necessarily be appropriate on another. Size of farm, stock number and type, management, land type, etc., will affect which control options are most cost-effective, while minimising the pressure that can lead to anthelmintic resistance.

In young cattle, probably the most important measure of performance is growth rate, whether animals are destined to be fattened for beef or replacement heifers.

Average growth rates of 0.7kg per day or more, on pasture are required if beef cattle are to be finished before they are two years old and replacement heifers are to calve at 24 months.

Although adult cattle are rarely the focus of routine worm control, they can be important epidemiologically and can experience production losses. They should not be ignored.

Control options

- Grazing strategies
- Strategic seasonal anthelmintic use to minimise pasture contamination
- Targeted anthemintic treatments of the whole group based on diagnostic information such as Faecal Egg Counts or weight monitoring
- Targeted strategic treatment of individual animals,based on monitoring stock health and growth rates
- Housing treatments

Figure 5: Aim to minimise pasture contamination.

Moredun Research Institute

Grazing strategies

Pasture may be available that has not had cattle grazing on it for at least a year, such as newly sown leys following a cereal or root crop. These are considered ‘clean’. If using clean pastures, first season grazing calves will have no opportunity to build up immunity.

Most livestock farms will have some hay/silage aftermaths available for the second half of the grazing season. These are considered to be ‘safe’ pastures for grazing, even if cattle were grazing there the year before. They can be exploited as part of a control programme.

If there are sheep on the farm, they can participate in mixed or sequential grazing, which can potentially benefit both types of stock through worm control and improved pasture utilisation. However, care must be taken when there are liver fluke on the farm, due to the risk of cross-infection between cattle and sheep. There are also considerations around Johnes Disease control when co-grazing sheep with cattle.

Anthelmintics

Anthelmintics can be used:

1. As an early season strategic treatment, where target groups of animals are treated, with the primary objective being to limit the contamination of pastures with worm eggs
2. Targeted – treat when needed based on the results of routine faecal egg counts or weight gains
3. Therapeutically - to treat individuals or groups which are already suffering losses. The aim of the control programme is to avoid this situation.

Early season strategic treatments are most effective when initiated early in the grazing season – assuming calves are turned out onto pasture that has been used the previous year for grazing cattle. Such pasture will be contaminated with larvae that have survived over the winter and will infect calves when they are turned out into the fields in spring. Treating calves early in the season, at or within three weeks of turnout (the pre-patent period), will kill worms before they reach maturity and prevent large numbers of worm eggs contaminating the pasture.

Overwintered larvae die off by early June, so no further treatments beyond the end of June should be needed until the calves are housed in autumn.

Examples of this approach are to administer a long-acting injection or bolus formulation at turnout, or a macrocyclic lactone (ML) given at three weeks after turnout, and then again at intervals that are determined by the persistence of each particular product, up the end of June. Thereafter, further treatments should not be needed, if the early season treatments were given at the correct intervals and the animals remain on the same pasture.

This type of control programme is classically applied to autumn/winter-born weaned calves in their first grazing season and sometimes to spring-born calves in their second grazing season.

The most effective early season strategic treatment regimes will impose a high selection pressure for resistance development. It is particularly important to avoid treating calves and then moving them to fresh pasture such as hay or silage aftermath. It is now well known that such protocols strongly select for resistance. If animals are moved, the risk posed by the next pasture needs to be assessed and appropriate steps taken to maintain control.

Targeted treatments are based on monitoring cattle over the grazing season and targeting treatments at the most highly infected animals when they are needed most.

Diagnostic and performance indicators can be used to monitor cattle performance to identify the ones that need treating. Many factors can affect how these targeted treatment options are implemented, including the availability of clean and safe pasture, an understanding of how contaminated pasture is – both early in the season, which may have overwintered larvae, and in mid-summer when larval numbers traditionally peak. Further details of monitoring options are given in section 7.

Therapeutic treatments. If no measures are taken to limit pasture contamination by using management or anthelmintic strategies, grazing cattle will be exposed to an ever-increasing risk of disease and production losses. They may suffer clinical parasitic gastroenteritis.

To address this, cattle can be closely monitored and treated when they start to show signs of ill-thrift and diarrhoea. Or tactical treatments can be given to at-risk groups in anticipation of losses. However, this can lead to production losses and greater pasture contamination.

It is extremely important to take into account the risk of lungworm infection when making any changes to control measures aimed at gastro-intestinal worms.

Housing treatments

Treatment of cattle for parasites at housing using anthelmintics can be considered as either strategic or therapeutic or both.

This treatment is strategic because when cattle go out to pasture the following year, they will not immediately contaminate pasture with worm eggs.

This treatment is therapeutic because worm burdens are removed, and cattle are free of their negative impact for the remainder of the housing period.

In addition, if products containing macrocyclic lactones (MLs) are used, inhibited *O. ostertagi* larvae will be removed and the risk of Type II ostertagiosis is minimised. Benzimidazoles may also be used if they are known to be effective against inhibited larvae.

It may be efficient to use more than one parasiticide and/or combination products at housing, as it is also an opportune time to treat for lungworm and liver fluke and to prevent lice and mange infestations later in winter.

Diagnostic information should be used and choice of products, should take into account the need for fluke control and especially the choice of fluke active ingredient.

> Use the product most suitable for the time of year and management of the cattle involved.
>
> See the Parasite Control Guide from AHDB for all the products available in the UK.

Quarantine

Incoming or returning stock should be tested and treated to minimise the risk of introducing resistant roundworms to the farm.

Cattle can be treated with anthelmintic, the treatment then efficacy tested (See Section 7) and animals retreated with a different class of anthelmintic if required. If possible, cattle should then be put onto pasture with a low/moderate parasite burden containing an *in refugia* population.

Section 7: Monitoring and Diagnostics

Given the changing and less predictable climate, calendar-based control programmes, as well as exerting significant selection pressure for resistance to products, may no longer be fit for purpose.

COWS strongly advocates an approach which assesses worm challenge in a group of animals, maximising animal performance while minimising anthelmintic use.

Anthelmintics remain a vital part of parasite control programmes but they should only be used when data indicate they are required.

Diagnostics and performance monitoring can help with decision-making particularly under variable weather conditions.

Performance monitoring and targeted treatment

In the presence of adequate nutrition and absence of other endemic diseases, parasitic gastroenteritis is the main factor determining animal growth rates at grass.

Monitoring infection in first and second season grazing calves can be done using faecal egg counts (FEC) and/or regular weighing of youngstock and treatment of those failing to reach growth targets or that have significant egg counts (>200 epg). This can result in good worm control, whilst reducing the number of anthelmintic treatments.

> **Parasite monitoring**
> - Regular weighing of young cattle
> - Faecal worm egg counts (FEC)
> - Plasma pepsinogen
> - Milk tests may be useful in dairy herds

This approach has the benefits of limiting pasture contamination, maintaining some anthelmintic susceptible larvae and providing an appropriate challenge to stimulate immunity. Importantly, this method can also help to slow the development of resistance.

Parasites are not evenly distributed among animals within a herd. Treatment of individuals that are performing poorly, or that have high faecal egg counts, can lead to a disproportionate reduction in total worm infections.

There is currently no practical method for measuring pasture contamination. Knowledge of grazing history

Table 1: The benefits and limitations of faecal egg counts

Benefits	Limitations
Provide an indication of levels of pasture contamination due to numbers of nematode eggs being passed out in faeces	Cannot reliably provide an accurate determination of total worm burden
Indicate presence of egg-producing adult female nematodes, but this is not necessarily quantitative	Not linearly related to liveweight gain in young cattle
Indicate which animals are contributing most to pasture contamination, providing a selection criterion for targeting anthelmintics to limit faecal egg output	Cannot determine nematode species in a dung sample, unless eggs are cultured
Indicate how effective an anthelmintic is at reducing trichostrongyle egg excretion	Cannot detect nematode stages which are not laying eggs, eg. Type II Ostertagiosis
Recent research on a small number of farms has shown dairy cows with a positive FEC at calving may have a reduced milk yield in that lactation	Cannot provide an estimate of abomasal damage especially in older calves or adults
Can be included in the differential diagnosis of ill-thrift and scour in pastured cattle	Standard FEC methods using salt flotation are not recommended for detection of lungworm, liver fluke or tapeworm eggs

with different classes of stock can help identify fields with likely high, moderate or low larval levels at a given time.

Monitoring growth rates

Monitoring growth rates can be used to focus treatment specifically on those animals which fail to reach a target average daily liveweight gain. However, this is only possible if an adequate plane of nutrition is provided, weighing equipment is available, and an appropriate weight gain target is set. A figure of 0.7 kg/day has been used in some farm trials. Others suggest using a target set for each particular farm/group of animals. For example, using the group's own mean average daily weight gain.

Faecal egg counts

Taking dung samples and measuring the concentration of worm eggs (faecal egg counts/FEC) can provide useful information about infection dynamics over a grazing season.

Faecal egg counts are a good choice for monitoring infection in young calves and are a good predictor of pasture contamination. However, they are a poor indicator of worm burden and production losses.

A threshold of 200 eggs per gram (epg) two months after turnout is often used to indicate that the calves are grazing contaminated pasture and highlight a need to treat.

An analysis of combined data from cattle systems across the world suggested a lower FEC threshold of 10 to 50epg is negatively associated with weight gain, but no data on what thresholds to use in the UK context is available.

Faecal egg counts do have their limitations, especially in adult cattle, which produce large volumes of dung which dilute the number of eggs. Therefore a low FEC result may be important.

Faecal Egg Count results will also be low in animals that are immune and only indicate the presence of adult egg laying female worms.

So, in adult cattle results need careful interpretation alongside other information, such as body condition, milk yield in dairy cows and knowledge about previous exposure to roundworms and treatment history.

Composite FECs can be a simple and convenient monitoring tool if carried out every three weeks during the grazing season for groups of first and second season grazing calves. They can indicate if cattle are on contaminated pasture, direct the type of treatment,

Basic guidelines for performing an anthelmintic efficacy check

1. Before doing a check, perform a FEC on a sample of 10–15 animals from the group to be tested, which should ideally be calves in their first grazing season.
   A pooled FEC is adequate and will save money. If egg counts are reasonably high (>200 epg) proceed with treatment. Treat at a lower threshold, eg. 50 epg, if an FEC method of higher sensitivity, eg. 1–10 epg is used
2. Collect faecal samples on the day of treatment (Day 0). Place at least 10g in total sampled from three different areas of each pat into an individually identified plastic bag for each animal. Exclude air and keep cool
3. Administer anthelmintic. Calculate dose from an accurate body weight (scales of weigh band). Ensure all the dose is swallowed or injected or poured-on appropriately
4. Collect faecal samples in the same manner 14–17 days after anthelmintic administration, or 7–10 days after treatment with levamisole
5. In all case, process faecal samples at the lab as soon as is feasible. Samples should be re-mixed before any sub-sampling to help account for variation within a single pat. A detection limit of 5 epg or less is considered best practice to reduce the chance of mis-classifying resistance
6. Calculate percentage efficacy using the formula:
   %FECR = ((Mean Day 0 FEC – Mean Day 14 FEC) / Mean Day) FEC x 100
   The percentage efficacy should be at least 95%
7. Pooled FEC can be used before and after routine treatment, even from fresh dung pats sampled at pasture to confirm good anthelmintic efficacy. This method is much cheaper and easier but not as accurate. Suspect efficacy from pooled counts should be followed up with a full check using individual samples whenever feasible. Individual tests allow a level of confidence in the calculated result

and alert farmers that the animals have been exposed to infections and therefore likely to develop immunity.

Plasma pepsinogen

The concentration of pepsinogen in blood plasma is related to the extent of abomasal damage caused by parasites, such as *O. ostertagi*.

Pepsinogen levels at the end of the first grazing season can indicate if exposure has been too high, causing production losses, or too low with consequent poor development of immunity.

Pepsinogen thresholds of >2.5 U Tyr have been used to guide treatment, since this level was associated with sub-clinical infections and reduced weight gain that was reversed on treatment.

Further work is warranted on the value of pepsinogen as a monitoring diagnostic tool for *Ostertagia* infection.

Worm antibodies

Antibodies are a measure of the host immune response to parasites. However, it is important to recognise antibody levels do not always correlate with the level of protective immunity.

The concentration of *O. ostertagi* antibodies in milk is related to exposure and can provide a good estimate of potential loss of milk caused by the parasite at herd and individual levels. High antibody levels can prompt treatment in dairy cows but should also trigger review of herd control strategies.

Section 8: Anthelmintic resistance

Anthelmintic resistance (AR) is a global problem that is common and widespread in sheep and goat roundworms. It is increasingly being observed in cattle parasites.

In Europe, the parasite species currently implicated most in AR is *C. oncophora*, but it is increasingly reported in *O. ostertagia*. The impact of this issue is currently unknown but early action is necessary to maintain efficacy of current anthelmintics.

The challenge is how to limit selection for, and hence delay emergence of AR and how to manage it when it does appear. Objective identification of risk factors for AR on cattle farms is lacking in Europe. The most obvious risk is the use of whole herd, frequent or continuous dosing regimens. Under-dosing may also allow (partially) resistant worms to survive treatment.

There are a number of common-sense practices that should help to limit selection pressure on cattle worm populations (see Section 1: Top Tips for controlling parasitic gastroenteritis in cattle) without compromising worm control.

In addition, some of the newer approaches to parasite control, such as the Targeted Treatment approach in Section 7, can help farmers continue with successful production into the future.

Section 9: Planning control on farm

Practical control advice should be tailored to the individual farm and consider:

- Production objectives for the different classes of cattle
- Farm infrastructure, particularly in relation to pastures, grazing management and handling facilities
- Presence of other helminth parasites, such as lungworm and liver fluke
- Efficacy of available anthelmintics.

Equipped with this information, it is possible to compile a risk assessment for parasitic gastroenteritis in all categories of stock.

This assessment is dynamic and needs to be reviewed several times during the grazing season. In addition, housing and turnout are good times to reflect on the previous months and plan for the future.

Once risks have been quantified, it is possible to decide on control options, using management, diagnostics and testing, monitoring and anthelmintics if required.

The actual choice of anthelmintic is ideally determined through discussions with the vet, RAMA or SQP at retail outlets. For more information also see the COWS Integrated Parasite Control chapter.