Introduction
Gastrointestinal nematode (roundworm) infestation is the most important infection limiting sheep production in the UK. The important nematodes are:

- **Nematodirus battus** - affects young lambs during the late spring or early summer,
- **Teladorsagia** and **Trichostrongylus** species - cause parasitic gastroenteritis of growing lambs from mid-summer onwards. Disease may also be seen in older animals where control measures are inadequate or where there is concurrent disease e.g. Johne’s Disease which contributes to immunosuppression.
- **Haemonchus contortus** - affects both lambs and adult sheep

Nematodirosis
In the UK, Nematodirosis is an important disease affecting six to 12-week-old lambs during the late spring and early summer months. Only lambs are affected, ewes do not show disease, and losses may be significant.

**Figure 1.** Parasitic gastro-enteritis affecting a growing lamb

**Figure 2.** Nematodirosis affects young lambs during the late spring or early summer. Ewes do not show disease.

**Figure 3.** Sudden onset diarrhoea in a lamb caused by grazing pasture contaminated with large numbers of infective Nematodirus larvae.

The hatching of Nematodirus eggs on the pasture is dependent on a period of cold weather followed by prolonged warmer conditions. If the hatch coincides with lambs beginning to graze, then large numbers of infective larvae on the pasture can result in severe disease outbreaks.
Figure 4. Sudden deaths are not uncommon from nematodirosis in severely affected lambs.

Due to the specific weather conditions required for the hatch, it is possible to accurately predict the timing of the highest risk periods, and preventative measures can be taken to limit the effect of disease. The risk of disease may also be significantly reduced by employing grazing rotation strategies to ensure young lambs do not graze pasture that had ewes and lambs on the previous year. Lambs which recover from Nematodirus infection following anthelmintic treatment will have a slower growth rate and take much longer to achieve market weight.

**Teladorsagiosis and Trichostrongylosis**

Teladorsagiosis is typically seen in growing lambs and causes profuse watery diarrhoea during mid to late summer. In contrast, Trichostrongylosis frequently causes disease in autumn or winter, when eight to ten-month-old lambs present with dark coloured, foul-smelling diarrhoea.

Figure 5. Trichostrongylosis is normally seen during early winter affecting 8 to 10 month-old lambs

Figure 6. Trichostrongylosis affecting a Scottish halfbred hogg during early winter.

All ages of sheep carry these roundworms, but adult sheep mostly have good immunity and rarely show signs of infection. Ewes lose their immunity around lambing time – the peri-parturient rise (PPR) and are the main source of pasture contamination for growing lambs as they start to graze.

Towards the end of the summer, worm larvae within the gut may become encysted or hypobiosed – effectively hibernating in the wall of the intestine – until the following spring, when mass emergence of larvae can cause disease similar to Type II Ostertagiosis in cattle. In these cases, the faecal egg count will be negative as there are no adult worms laying eggs and diagnosis must be made by post mortem examination.

Figure 7. Lifecycle of Teladorsagia

**Haemonchosis**

Haemonchus contortus, or the Barber’s Pole worm, lives within the abomasum of affected sheep and feeds on
blood through the stomach wall. All ages of sheep can be affected, and diarrhoea is not a feature of this infection. The severity of clinical signs depends on the number of infective larvae ingested. Ingestion of large numbers of larvae over a short period of time causes acute disease with severe anaemia, lethargy, weakness, and sometimes collapse and death. Ingestion of smaller numbers of infective larvae over several weeks to months causes a more general loss of condition progressing to emaciation, moderate anaemia and bottle jaw.

Figure 8. Chronic Haemonchosis presenting with anaemia and bottle jaw.

Figure 9. Severe, acute Haemonchosis in a Suffolk shearling causing lethargy, weakness and rapid loss of condition.

**Tapeworm infestations**
While segments of tapeworms are often seen in the faeces of growing lambs in the UK they exert no adverse effects on growth rate and treatment is not usually considered necessary. The use of group 1-BZ wormers in lambs will remove tapeworm infection.

**Clinical signs**
The severity of clinical signs of parasitism depends on the animals resilience which is affected by:
- Age
- Current nutritional status especially protein intake
- Immune status and concurrent diseases
- Trace element status
- Genetics

Subclinical infestations with roundworms may cause inappetence, reduced growth rates, poor wool quality and reduced milk production in ewes. If worm burdens are large or resilience is poor, signs will be obvious, especially in growing lambs during the warm summer months:
- Diarrhoea
- Weight loss
- Dehydration
- Death

Figure 10. Clinical signs of scour and significant weight loss are seen if worm burdens are high or resilience is low.

In cases of Haemonchosis clinical signs are different. Depending on the number of larvae ingested, and the time span over which this occurs, signs may range from mild anaemia, loss of condition and bottle jaw to emaciation, severe anaemia, lethargy, collapse and death. Diarrhoea is not a feature of Haemonchus infection.

Figure 11. In haemonchosis the most important clinical
Diagnosis

Faecal egg counts (FEC) are routinely used to aid diagnosis of nematode infestations but have certain limitations:

- Faecal egg counts may not accurately indicate the nematode population present in the gastrointestinal tract at that time. Disease can be caused by developing larval stages before adult worms are present and laying eggs.
- By identifying strongyle eggs rather than individual species of worm (it is not possible to do this on a FEC), there is potential for less harmful species to make a disproportionate contribution to the total egg count and result in unnecessary advice to treat.
- The worm burden does not affect all animals the same: about 90% of the worms live in approximately 10% of the sheep, so an individual sample will not be representative of the flock situation.

Therefore, it is important to use FECs in conjunction with other monitoring and diagnostics such as clinical signs, regular weighing, grazing history and post-mortem examination.

Dung samples for FEC should be fresh when collected (less than one hour old) and kept cool (but not frozen) in an airtight container or plastic bag. Examination or delivery to the laboratory must be within 48 hours. If the faeces are too old, some eggs will have hatched and the reported egg count will be an underestimate.

For more information see https://www.scops.org.uk/workspace/pdfs/making-the-most-of-fecs.pdf

In the UK it is important to seek veterinary advice as clinical signs of Haemonchosis can be very similar to those seen with liver fluke infection. Faecal egg counts are often very high in patent infestations with counts greater than 10,000 eggs per gram (epg) not uncommon. At necropsy very large numbers of adults are visible on the surface of the abomasum (fourth stomach compartment) of untreated sheep.

It is important to consult your veterinary surgeon regarding your farm situation as diagnostics and control plans should be tailored to your individual circumstances.

Treatment

Treatment of PGE involves the use of an effective anthelmintic. The five major anthelmintic groups comprise:

For a comprehensive list of products and their active ingredients, along with information about correct dosing technique see https://www.scops.org.uk/workspace/pdfs/know-your-anthelmintic-groups.pdf

Some flukicidal products, such as nitroxynil and closantel are also effective against Haemonchus contortus and should be considered in certain cases.

The choice and timing of treatment should be discussed with your vet in order to minimise the chance of selecting for resistant worms. Sheep must be weighed, dosing equipment clean and calibrated, and the correct technique employed to ensure accurate dosing.

Targeted selective treatments (TSTs) provide a way to reduce the risk of selecting for resistant worms by only treating the animals within a group affected by worms. Performance indicators such as weight gain and FECs can be used to identify those animals which require treatment. By using this method it should be possible to only treat 40-60% of the group. Good record keeping is essential for TSTs to work successfully on farm.

Whilst there is widespread and growing resistance to group 1, 2 and 3 wormers within the strongyle worm species (Teladorsagia, Trichostrongylus), there is no evidence of similar trends in Nematodirus. Therefore group 1-BZ drenches are still considered effective for the treatment and control of PGE in young lambs in late spring.

If there is suspicion of treatment failure then post-treatment FEC (drench test), or faecal egg count reduction test (FECRT) should be carried out under the instruction of your vet.

Grazing management

The life cycle of Nematodirus is reliant on a lamb to lamb infection cycle. Rotational grazing so young lambs are not on the same pasture as the previous years’ lambs will reduce the risk of infection being perpetuated from year to year. If this is not possible then making use of the NADIS and SCOPs forecast allows vigilance during the risk period and preventative dosing if necessary.
Figure 13. Follow veterinary advice and forecasting for early season control of Nematodirosis

With traditional management of sheep on permanent pasture in the UK, parasitic gastroenteritis in growing lambs results from ingestion of very large numbers of infective larvae from pasture during the summer months. Pasture larvae arise from two sources:

- Eggs passed by ewes around lambing. The reduction in ewe immunity permits a significant increase in egg production during the last two weeks of pregnancy which may persist until eight weeks post lambing. This is known as the periparturient rise (PPR). Under suitable environmental conditions these eggs develop to infective larvae within three weeks but maximum levels may not be present on pasture for up to six weeks. These larvae are the major source of infestations in young lambs.

- Young lambs may also ingest over-wintered infective larvae from pasture. These animals have not yet developed immunity to the worms, so the adult worms can produce large numbers of eggs resulting in the appearance of significant numbers of infective larvae on pasture in mid-summer.

Figure 14. An integrated pasture management policy can be drawn up as part of your flock health plan

Control is based on not grazing potentially heavily infested pastures with susceptible lambs. Avoidance of infested pastures from July onwards can be integrated into some farm management systems by moving weaned lambs onto hay or silage aftermaths from mid-June onwards. On some mixed farms, it may be possible to rotate pastures annually between cattle and sheep and operate a "modified" two-year clean grazing system.

Care must be taken when buying in stock from other farms as without sufficient quarantine protocols it is very easy to introduce resistant worms into the flock. A period of at least 3 weeks isolation coupled with a quarantine drench will significantly reduce the risk of this occurring.

Figure 15. Establish effective quarantine protocols with your vet as part of your flock health plan

Anthelmintics can be administered to both ewes and lambs to prevent the build-up of critical larval populations on continually grazed pasture but this is not sustainable. This practice will increase selection for resistant strains.

Preventative Use of Anthelmintics

The rationale behind treating ewes is to reduce the number of worm eggs she puts onto pasture when her immunity lowers around lambing. Along with larvae that have overwintered, this will be the source of the worms that will challenge lambs later in the season. It is possible to identify ewes shedding many eggs from those shedding few by faecal egg counts (FEC) and body condition scoring (BCS). Treatment can be selective.

Figure 16. Targeted anthelmintic treatment can be used to prevent high egg output by the highest risk ewes.
The importance of good ewe nutrition during pregnancy and early lactation should not be underestimated with respect to parasitic gastroenteritis. The ewes that produce most eggs are generally the ones under the most pressure in late pregnancy. This includes ewes in lower body condition, younger ewes and triplet-bearing ewes. These are the priority to be wormed around lambing.

To reduce the risk of selecting heavily for resistance in the worms, it is recommended to leave 10-20% of ewes untreated in each grazing group, not just across the flock. However, producers that have been monitoring faecal egg counts are finding a much higher proportion can be left untreated if ewes are fit and healthy, without any detriment to lamb performance.

Independent UK research carried out by the Animal and Plant Health Agency (APHA), funded by the Veterinary Medicines Directorate (VMD) and published in 2018 found no advantage in blanket worming ewes at lambing. Faecal egg counts from lambs reared on ewes that were wormed with either a short or long-acting (persistent) wormer were not lower than faecal egg counts taken from lambs reared on ewes not treated with a wormer.

Tempting though it may be, routinely using persistent products year-on-year in ewes risks developing resistance to the clear (3-ML) group of wormers. To avoid this, these products need to be used carefully and the following points understood:-

- It is essential to leave 10-20% of ewes untreated if using a persistent wormer.
- The length of time the wormer persists is not the same across all worm species.
- Treating ewes will not have any effect on your lambs risk from Nematodirus.
- Do not use in ewes year-after-year and certainly not if ewes are going into the same fields as last year, or are being turned out onto low-risk pasture.
- Selection for resistance is a risk because suckling lambs are exposed to a low dose of the wormer via the ewes’ milk.

The timing of early season drenching to control Nematodirosis has been discussed above but essentially comprises a strategic anthelmintic drench(es) depending upon disease forecasts. (see: www.nadis.org.uk and at www.SCOPS.org.uk ) While such forecasts are reasonably accurate, your veterinary surgeon will advise regarding local conditions and specific risk periods.

Figure 17. Individual farm sustainable PGE control measures will be devised by your own veterinary surgeon as part of a flock health plan.