Worm control in sheep

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Contents

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Introduction

Effective worm control is essential to the success of sheep farming in the UK. Historically, we have been heavily reliant on the use of anthelmintics (wormers) to help us reduce the impact of worm burdens on flock performance. Unfortunately, this has led to overuse of these products and resulted in the development of worm resistance to the older generation of wormers. To ensure we can continue to minimise the impact of worms in our flocks, we must adopt practices that reduce our dependence on these medicines, which integrate the two newest anthelmintics (4-AD and 5-SI) carefully into strategies, and ensure every dose given is fully effective.

In addition to reducing our reliance on wormers, we also need to make sure that those we do use are working effectively. However, while anthelmintic resistance (AR) to wormers is now accepted as a challenge by most sheep farmers, relatively few know what the AR status is on their own farm. This is because AR creeps up gradually over a number of years and the effects are often not obvious until there is a complete failure. In the intervening years, lamb performance falls as fewer and fewer worms are killed by a treatment, often going unnoticed or blamed on other issues such as trace element deficiencies. The only way to know the AR status is to test on a regular basis and at various times of year. This will bring about immediate benefits in terms of lamb performance, as well as help to provide control that is sustainable through the years to come.

This manual will take you through the principles of sustainable control, testing and management options and provides some case studies as a guide to practical implementation on farm.

SCOPS

Sustainable Control of Parasites in Sheep (SCOPS) is an industry-led group, which was formed to develop sustainable parasite control strategies for sheep. Based on scientific evidence, the SCOPS recommendations incorporate the practicalities of sheep farming and animal health planning to inimize our reliance on parasiticides. These strategies are also directly relevant to those who are striving towards a more regenerative approach to farming, because they encourage effective treatment only of those animals that require it, thus minimising environmental impacts.

The SCOPS principles for best practice and responsible control of worms are to:

- Always ensure that any anthelmintic treatment given is fully effective. Choose the right product, at the right time, for the right animal and at the right dose rate and test after treatment
- Try to reduce your reliance on anthelmintics using management options and monitoring strategies, such as faecal egg counts (FECs), targeting treatments and grazing options
- Avoid bringing resistant worms and other parasites onto the farm by following a robust quarantine routine
- Minimise selection for resistant worms when sheep are treated with anthelmintics by avoiding highly selective practices such as ‘dose and move’

For more information, see **scops.org.uk**

Why do we need to control worms?

Worm control is vital for good growth rates and profitable sheep systems. Heavy burdens result in stunted growth or dead lambs. Even a modest worm burden, with no clinical signs of infection in lambs, can reduce performance and increase costs.

How worm burden affects lambs

Lambs that are burdened with worms may suffer from the following symptoms:

- Reduced feed intake and growth rate caused by a depressed appetite
- Small skeleton because of impaired mineral retention and exacerbated trace element deficiencies
- Reduced muscle growth and carcase quality due to poor protein metabolism
- Permanent gut damage which can reduce nutrient absorption and lead to symptoms of diarrhoea

Worm burden can significantly reduce feed use efficiency (FUE), as illustrated in Figure 1. Reduced FUE can result in daily liveweight gain (DLWG) of 100 g a day, in comparison with a healthy lamb which you can expect to be achieving a DLWG of 300 g per day. This is because the feed efficiency is halved, from 16% to just 8%.

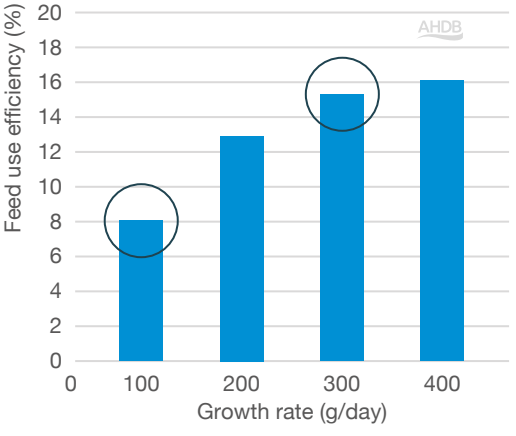


Figure 1. Efficient lamb performance

A weaned lamb growing at 100 g/day needs nearly twice as much energy to reach the same weight as a lamb growing at 300 g/day. The impact of this on weeks to finish and feed dry matter is illustrated in Figure 2. Both lambs need to gain 10 kg to finish.

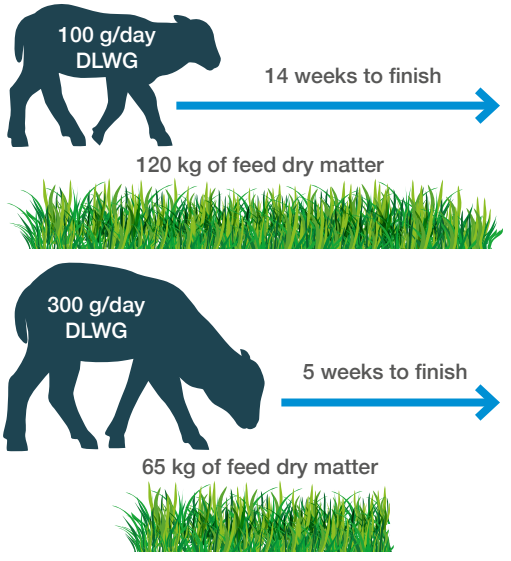


Figure 2. Lamb with 8% FUE in comparison with lamb with 16% FUE

Lamb prices could also decrease over the additional nine weeks it takes to finish lambs. A 30p/kg reduction would lower the value of the lamb by £5.70 (for a 19 kg carcase). Combined with the additional costs of feed and grass, the financial cost quickly reaches £10 per lamb.

The impact of anthelmintic resistance (AR)

What is anthelmintic resistance?

A worm is said to be resistant when it can survive exposure to the recommended dose of an anthelmintic (wormer). This ability to survive is genetic and is inherited by the next generation. Over time, the proportion of worms carrying resistance genes increases and once this reaches over 50%, the process is irreversible.

Routine treatment of sheep with anthelmintics worked well for many years, but on many farms, one or more of the three older, broad-spectrum chemical groups (1, 2 and 3) is no longer fully effective.

Resistance builds gradually

Resistance does not happen overnight – it builds up gradually over time, as illustrated in Figure 3. Many farmers are unaware that their anthelmintic treatments are losing effectiveness and reducing lamb performance until the 50% point is reached – by which time, it is too late to reverse. This is why testing for resistance is so important. Testing gives us an early warning that resistance is starting to develop to an anthelmintic group, so lamb performance can be maintained by swapping to another group. Careful and regular checking, combined with reducing our reliance on anthelmintics, can also mean that one or more of the older groups can still be used successfully, at certain times, on most farms.

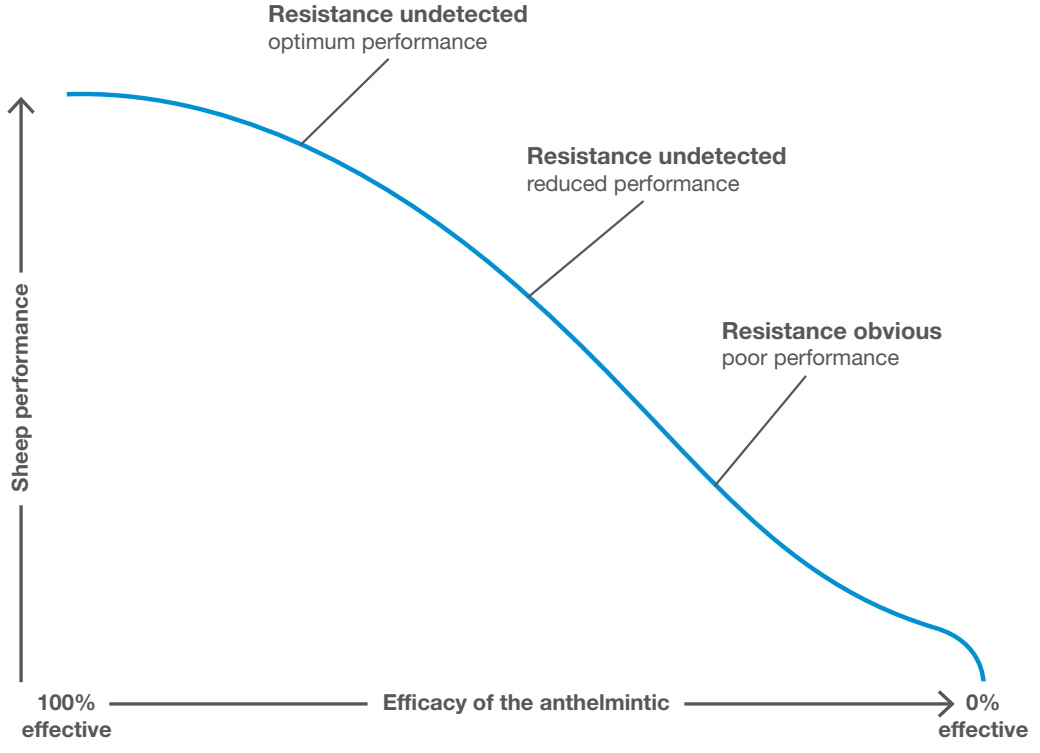


Figure 3. Anthelmintic resistence graph

Source: SCOPS

Anthelmintic resistance in the UK

Surveys and reports from farms in the UK suggest that resistance to the first three groups of anthelmintics is increasing. Most farms have some resistance to the white (1-BZ) group; resistance to the other two older groups is less common but increasing year-on-year. Resistance will be farm specific and will vary between worm species found on each farm.

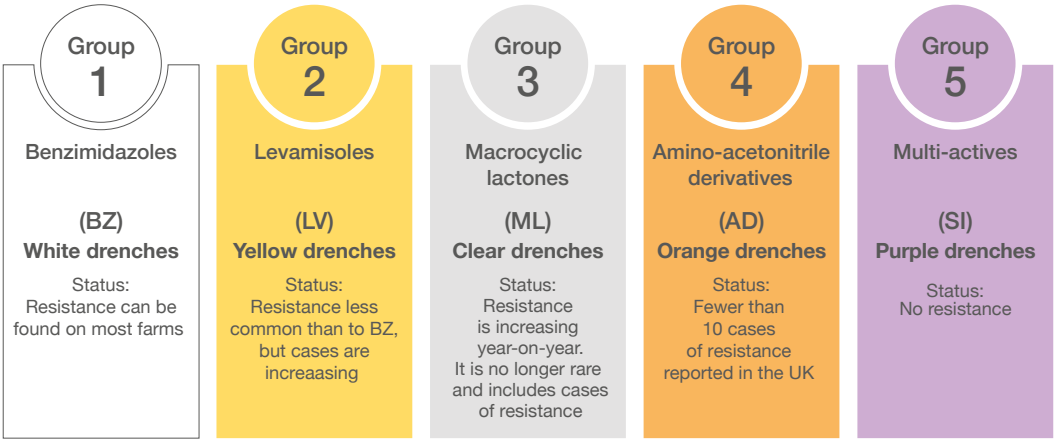


Figure 4. Chemical groups and their effectiveness in the UK

Worm species and key actions

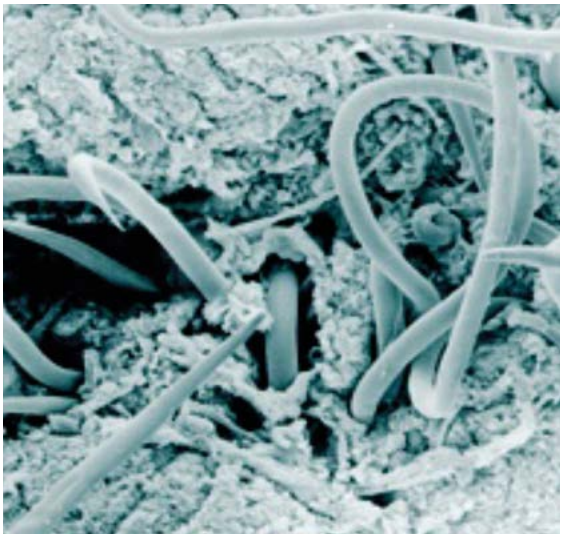
Teladorsagia – small brown stomach worm

Teladorsagia circumcincta, formerly known as *Ostertagia*, builds up during late spring and into summer.

At low-to-medium levels, it depresses appetite in lambs, which reduces growth rates and causes general ill thrift. Levels peak from midsummer, increasing the risk of losses caused by heavy infestations.

Key action

Use faecal egg counts (FEC) to determine the need to treat and avoid peak infection levels by weaning and moving lambs to lower-risk grazing.



Teladorsagia – small brown stomach worm

Nematodirus *(Nematodirus battus)*

This worm has a longer life cycle than the other worms mentioned and it normally only affects young lambs. Eggs deposited in spring hatch the following year when larvae are picked up by six-to-twelve-week-old lambs. A sudden, heavy challenge can result in significant losses. Due to the immature larvae that damage the lamb's gut, it is important to use forecasts and risk assessments to determine the timing and need to treat lambs and not rely on faecal egg counts alone.

Key action

Try to avoid putting young lambs on the same pastures each spring, particularly in areas of high challenge in the previous year. Use regional forecasts (**scops.org.uk**) to help predict when these worms will hatch, in conjunction with a risk assessment.

Nematodirus (*Nematodirus battus*)

Trichostrongylus – black scour worm of the small intestine

Trichostrongylus (*Trichostrongylus spp.*) is most commonly seen in the autumn in lambs but can occur earlier under the right conditions. It typically causes rapid weight loss, scouring and death, particularly in poorer lambs.

Key action

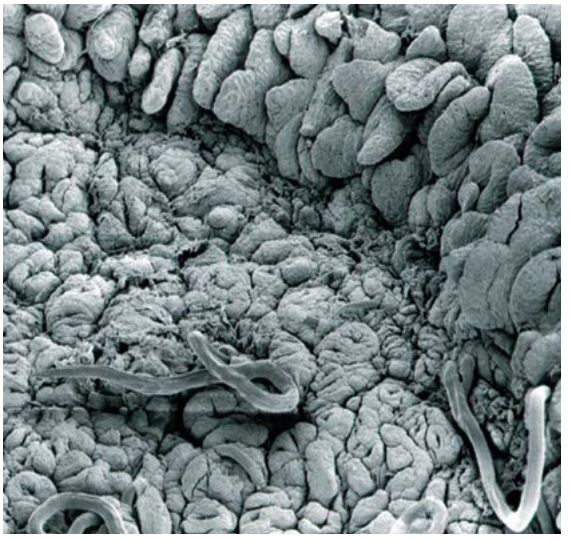
Try to avoid high-risk pastures. Grazing dry, fit ewes can reduce worm burdens on autumn-finishing pastures. Continue to monitor FECs throughout the autumn and winter.

Haemonchus – barber's pole stomach worm

Haemonchus contortus (barber's pole worm) is a bloodsucking worm which causes ill thrift, loss of condition and anaemia, rather than scouring. Changing climatic conditions means it is now more widespread across the UK. It can affect adult sheep as well as lambs, so it is important to know if it is present on a farm. Heavy infestations can occur very quickly in the right conditions, causing significant losses in both ewes and lambs. The first sign is often a very high FEC and/or loss of condition.

Key action

Quarantine treatment is essential to prevent the introduction of Haemonchus. It is essential to investigate unexpectedly high FECs and/or loss of ewe body condition and anaemia/bottle jaw.



Trichostrongylus – black scour worm of the small intestine

Haemonchus – barber's pole stomach worm

Carrying out a faecal egg count (FEC)

A faecal egg count (FEC) indicates the number of worm eggs in faeces (dung) and is used to monitor the worm burden in sheep. The results are presented as eggs per gram (epg) and the number of eggs is an indication of the number of adult worms laying eggs in the gut of the sheep.

Do not underestimate the importance of collecting a good, representative sample when undertaking a FEC. Visit **youtube.com/@Moredun** to watch a video for tips on collecting good-quality faecal samples.

FECs can be used to:

- Help determine the need to treat
- Test the efficacy of a treatment – see page 22 for more information
- Give information on the amount of contamination going onto the pasture using a farm map. See page 36.

Collecting the right samples

Individual samples can be collected directly from the field. You can either run the sheep into a small pen or corner of the field for a few minutes or gather the samples while shepherding, taking fresh samples as they are dropped.

Collection guidelines

- Only take samples randomly from freshly deposited faeces (ideally, still warm to touch)
- Collect at least 5 g of faeces or around seven faecal pellets per individual sample. Be consistent across all samples so that one sample doesn't dominate your result
- Collect a similar amount from each sheep sampled to maximise the accuracy of the FEC result
- Take samples from a minimum of 10 different animals, preferably 15. You do not need to mark the animals
- Try to avoid collecting any faeces that are in direct contact with the soil because soil may contain a lot of nematode eggs. Also avoid collecting grass and stones as this can change the sample weight when weighed out at the lab
- If not sent immediately, samples can be stored hygienically for a day or two in a refrigerator or cool box

Example of a fresh faecal sample

Example of a poor faecal sample

Worm life cycle

Understanding the life cycle of worms is important if we want to predict when they are most likely to be a problem and when to take action.

The life cycles of the main worm species are similar. Sheep (the host) pick up worms in the form of infective larvae living on the pasture. These larvae mature into adults inside the sheep's gut and produce eggs, which are deposited back onto grass via the dung. These eggs hatch and develop into larvae in the dung. They then migrate onto the grass, where they wait in water droplets to be eaten by another sheep, thus continuing the cycle.

The time it takes for eggs to develop into infective larvae varies according to ambient temperature and moisture.

In a warm, wet summer, it can be very quick (less than two weeks); in spring and autumn, when it is colder, it takes longer.

Worms have developed a survival strategy, which allows them to halt their development as winter approaches. Some survive as larvae on pasture, while others become dormant in the gut of the sheep. The following spring, the larvae on pasture become infective and begin their life cycle as temperatures rise, while those in the gut of the sheep resume egg production. Both are a source of infection for young lambs.

Nematodirus is the exception because its larvae takes much longer to develop: around eight to nine months.

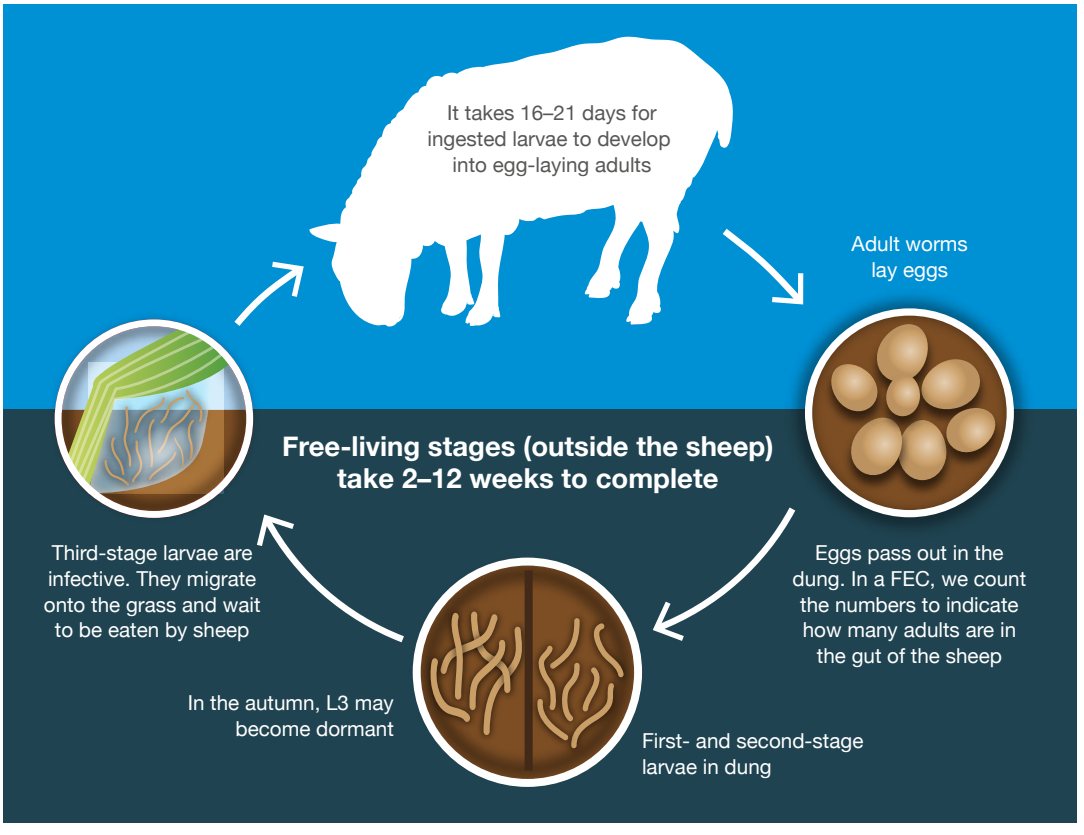


Figure 5. Life cycle of worms

Elements of successful worm control

The priority for worm control is to minimise the effect of internal parasites on flock performance and safeguard the long-term sustainability of the control programme in terms of anthelmintic resistance. This means sheep farmers cannot rely on anthelmintics as the sole means of control and must integrate a variety of management actions into their strategy.

A successful control plan includes:

- A worm control strategy integrated into an animal health plan that is adaptable to changing patterns of worm challenge and reviewed regularly with the farm's vet or adviser
- Knowledge of the different worm species, when they are a threat and why, using freely available regional forecasts and warnings (for example, from SCOPS, **scops.org.uk**, or the National Animal Disease Information Service (NADIS), **nadis.org.uk**)
- Monitoring worm burdens using FECs and planning ahead
- Reducing reliance on anthelmintics using grazing management practices, alternative forages and targeting treatments to those sheep that need it
- Using knowledge of contamination history and the farm map to avoid pastures where a high risk is predicted
- Minimising the risk of importing anthelmintic-resistant worms or new parasites with bought-in sheep with treatments in quarantine
- Ensuring any treatments administered are always effective and that their efficacy is tested regularly for evidence of resistance
- Allowing lambs, particularly breeding replacements, to develop immunity to worms and exploring the potential to breed for sheep with a higher immune response

Reducing reliance on anthelmintics

Anthelmintics are a vital worm control tool, but if we are to maintain the effectiveness of these products in the future, we must reduce our dependence on them.

There are several ways we can achieve this – for example, by:

- Understanding the worm species and challenges the flock will face in order to plan ahead (see Figure 6)
- Using FECs to monitor the worm burden in ewes and lambs and to help determine when/if they need to be treated and then testing that the treatments have been effective. FECs also provide us with the knowledge of the build-up of contamination on pastures
- Using grazing management practices and alternative forages to avoid pastures with a high challenge
- Targeting treatments to those sheep that need to be dewormed, rather than blanket-treating the whole mob or flock
- Harnessing the sheep's ability to develop immunity to worms, which allows them to manage their worm burden without clinical disease or loss in performance

Worm challenges throughout the season

The challenge to sheep from worms builds up over the season. A successful control strategy considers these dynamics. Figure 6 is an example for a spring-lambing flock.

Optimising anthelmintic use in lambs

Lambs that are grazing start to acquire immunity to worms when they are about five months of age, but, in most cases, immunity will not be fully developed until they are at least 12 months old. This means that lambs are the most vulnerable sheep in the flock. Worm control largely revolves around minimising their performance loss caused by worms over the grazing season.

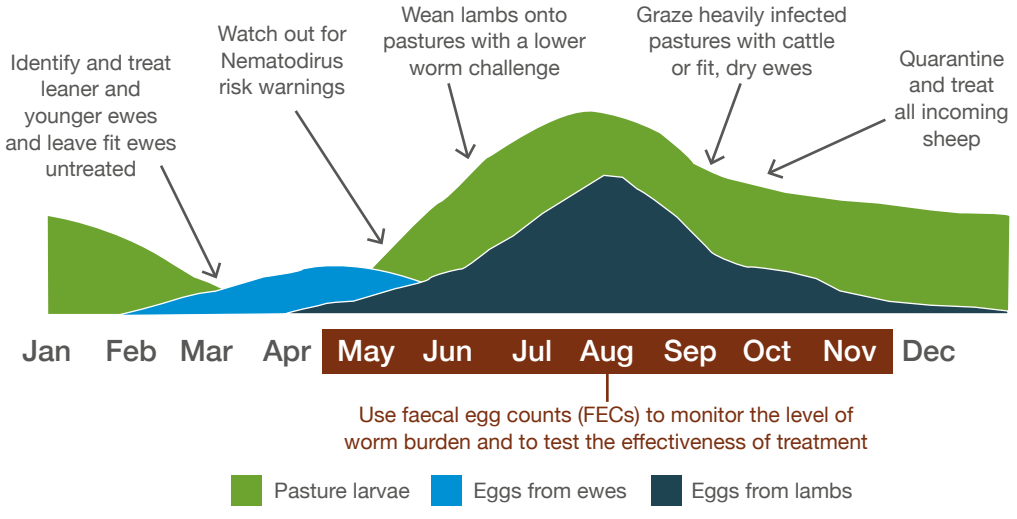


Figure 6. Diagram of worm challenges throughout the season

Grouping lambs by age after lambing makes treatment, management decisions and FEC results more accurate.

See page 16 for guidance on anthelmintic use in adult ewes.

Strongyles

The build-up of these worm species can be monitored using FECs, starting when lambs are about six weeks old. Regular FECs not only reduce unnecessary drenching, but ensure that timing of treatment is more accurate. This helps to build a picture of how worm burdens are developing on pastures. It is usually recommended to undertake a FEC every three to four weeks in each mob, plus drench tests after treatments to check the efficacy of the anthelmintic used.

Nematodirus

For lambs grazing pastures that carried lambs during the previous spring, Nematodirus is normally the first worm challenge (see page 7). Nematodirosis can strike very quickly and because the damage is caused by large numbers of immature larvae, FECs alone are not a reliable indicator of risk. Rapid action is often required, and this must be based on a risk assessment and the forecast for your area.

Targeted strategic treatments (TSTs)

This approach is aimed at identifying lambs within a mob that do not need treatment because they are able to perform well, even in the face of a worm challenge.

The aim is to leave 10–20% of the fastest growing untreated. However, if lambs are weighed regularly and growth targets set based on grazing available and weather conditions, many producers are finding they can target more accurately, often resulting in far fewer lambs requiring treatment.

Case study

Peter Eccles, East Lothian – The benefit of a sustainable roundworm control strategy in a commercial flock

Saughland Farm in East Lothian is an intensive sheep operation. Peter Eccles and his team are stretched at times during the summer when large numbers of lambs require dosing.

Fears over the possible implications that anthelmintic resistance could have on the sheep enterprise at Saughland, as it becomes more intensive, prompted them to explore a more sustainable approach to worm control.

Dr Fiona Kenyon from Moredun Research Institute introduced Peter to a targeted selective treatment (TST) strategy, which works by weighing the lambs at weaning and then measuring the feed available to these lambs to predict how they should perform.

The lambs are weighed every three to four weeks and those not achieving their predicted weight are treated for roundworms. For any lambs that meet their target weight, it is assumed that their performance is not affected by roundworm burden, so they are released back to the field untreated. By only treating the underperforming lambs, this approach has been shown to produce multiple benefits. It:

- Reduces the use of anthelmintics, with no reduction in lamb weight gain
- Provides an economic benefit from reduced anthelmintic use and time
- Helps to slow the development of roundworm resistance

Roundworm resistance is widespread in sheep flocks throughout the UK and we urgently need to address this by using more sustainable control strategies. TST is one such strategy.

As the untreated lambs are released back to the field, they continue to shed non-resistant roundworms, which then compete and suppress the resistant roundworms in the pasture. If all the lambs were dosed, only the resistant roundworms would survive, which are then shed onto the pasture. With less competition from non-resistant roundworms (because these were killed when dosed), the resistant roundworms thrive and continue to build the resistant roundworm population.

Results of using TST at Saughland:

- 60% of lambs did not need dosing
- 60% saving in product
- Lamb weight gain remained stable
- Less physical work
- Equipment works well – an electronic weigh crate and electronic ID (EID) tag reader, which can record animal numbers and link to animal weight
- Time- and labour-saving

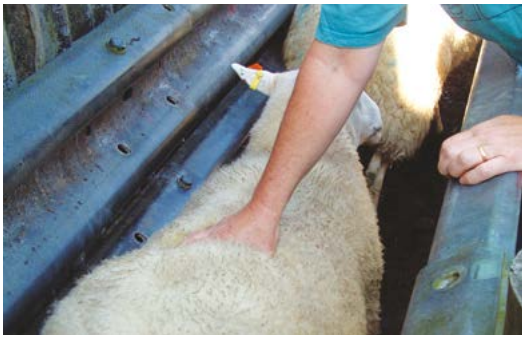
Installation of the sheep-handling system at Saughland to record data and run the TST programme has enabled knowledge exchange with the wider farming industry. Currently, TST takes time to set up and manage, and the calculations for each group require input from Moredun Research Institute. However, Moredun Research Institute, along with partner farmers and consultants, is looking to further develop and automate the TST algorithm. The results generated by this case study at Saughland will directly contribute to the commercialisation of this process, which – in time – will lead to wider uptake within the farming community.

Peter is also taking part in a study to develop and improve the best-practice advice for worm control. Peter sends faecal samples every time he treats his sheep for roundworms to Moredun Research Institute where a FEC is taken, the worm species are identified and the results are fed back to Peter in near-real time. Because these samples are collected throughout the year, the results provide a huge amount of information about the worm species present on the farm, how well the anthelmintic drugs are working and, importantly, which worm species, if any, are surviving the treatment.
This project is funded by the Veterinary Medicines Directorate and is led by Queen's University, Belfast. These projects have demonstrated the mutual benefits of farmers engaging and collaborating with Moredun Research Institute to develop real solutions, which can be implemented on commercial farms.

Reducing anthelmintic use in ewes

Sheep develop an immunity to most worm species by the time they are about 12 months old, if they are exposed to worms during this time. The immune system ensures most of the worms the sheep eat are killed, only allowing a small number to establish in the gut. This immunity also controls the egg-laying potential of these female worms, which means we see very few worm eggs in the dung of fit, healthy adult sheep.

Traditionally, sheep farmers have wormed ewes twice a year: pre-tupping and around lambing. However, this is highly selective for resistance, so we must try to only treat those ewes that may benefit or those that are likely to create a large amount of contamination for lambs after lambing.



The key to whether a ewe requires a worming treatment is her body condition because this is a reflection of her level of nutrition. If a ewe is in good body condition, then her immune response is most likely to be strong and she does not require treatment.

Ewes pre-tupping

Only a small proportion of ewes may benefit from treatment pre-tupping. These are lean or immature sheep (i.e. ewe lambs and shearlings) whose immune systems may not be fully effective.

Consult your vet if the farm has a history of *Haemonchus contortus* (see page 8) or if you are treating for liver fluke or sheep scab. This should only ever be carried out based on appropriate testing.

Ewes at lambing

Fit, healthy, adult ewes use their immune system to keep worms in their gut under control and prevent them from laying eggs. As ewes approach lambing, the nutritional demands cause some ewes to lose this control, resulting in a sharp rise in the number of worm eggs deposited in their dung. This is known as the periparturient rise and, together with overwintered larvae, is a source of contamination on pasture for lambs later in the season.

The objective of worming ewes around lambing is to minimise this source of pasture contamination. Historically, most ewes received a worming treatment at this time. However, we now know that a relatively small proportion of ewes produce the majority of the worm egg output. Identifying these ewes minimises the numbers wormed and the selection pressure for resistance in the worms, as well as reducing cost and the environmental impacts of anthelmintics.

Which ewes to treat?

Recent research suggests it is those ewes under most nutritional stress that lose control and produce the highest number of worm eggs. We can identify those under stress and losing condition by assessing ewe body condition score (BCS). This is far more accurate than simply leaving a proportion of the fittest ewes untreated and in well-fed flocks, and means the numbers treated can be very low. This work has also shown that the time for egg output to rise varies between flocks depending on when the nutritional stress is highest.

Combining BCS and some monitoring of ewe FECs means we can time any treatments more accurately, rather than guessing when the periparturient rise occurs.

Key facts:

- The ewes likely to produce most worm eggs in their dung are those under nutritional stress
- By using body condition scores (BCS), we can target treatment to those losing condition and therefore under the most pressure. Many flocks are now treating very few ewes using this measure
- It is very important to minimise the proportion of ewes wormed if a persistent worming product (moxidectin) is used
- The timing of the increased egg output varies between flocks; it does not follow a set pattern. Monitoring ewe FECs can help ensure the timing of treatments is more accurate

Harness immunity through breeding

The strength of the immune response to worms varies from sheep to sheep. Part of this variation is known to be genetic, which means it is possible to selectively breed sheep that are more resistant to internal parasites. The benefits of this are:

- Lambs have the potential to perform better, for example, in terms of lamb growth rate, therefore require less frequent treatment with anthelmintics
- Lambs shed fewer worm eggs in their dung, thereby reducing the levels of larval challenge for other sheep (whether these have also been selected for worm resistance or not)
- Ewes sired by more resistant rams shed fewer worm eggs at lambing time, reducing pasture contamination, improving lamb growth rates and reducing ewe treatments around lambing
- The worm burden on heavily stocked pastures can be reduced over time

To get the best results from selective breeding for low-FEC EBVs (estimated breeding values), you will need to retain your replacement females.

Genetic influences on FEC

Research using Lleyn and Exlana data indicates approximately 15% (Strongyles) and 17% (Nematodirus) of the variation between animals can be explained by their genes. These breeds have been actively selected for worm resistance for many years, changing the genetic make-up of their sheep. Figure 7 shows sheep born since 2018 have lower breeding values; they are expected to put fewer eggs onto pastures as a result.

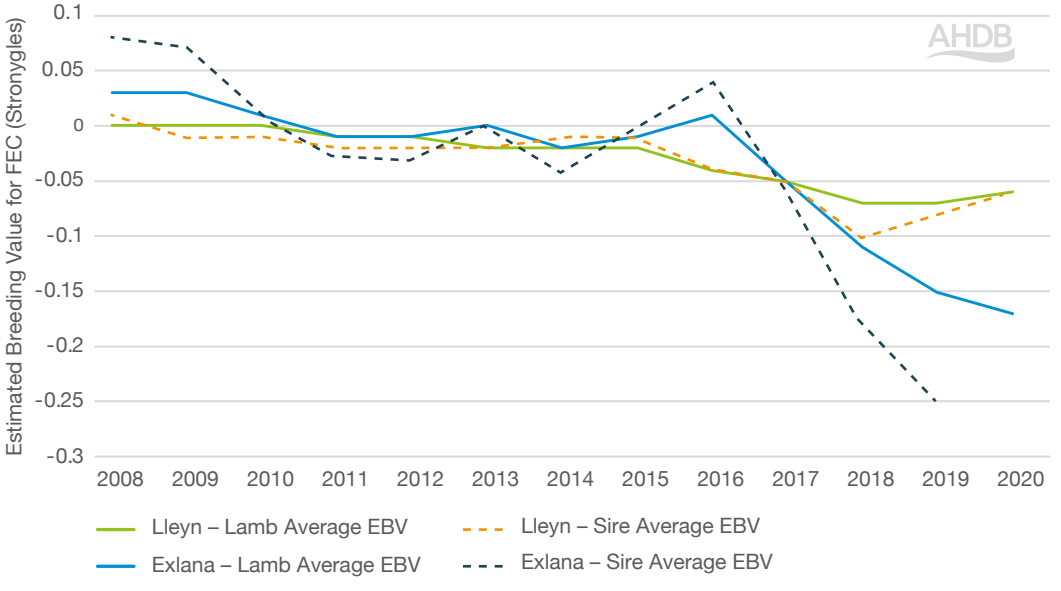


Figure 7. Genetic progress for FEC (Strongyles) EBV in Signet-recorded Lleyn and Exlana populations

New ways to assess worm resistance

Breeders are interested in new ways to assess worm challenge as the use of FECs to assess individual animals can be challenging, given the cost, impact on animal performance and the low repeatability sometimes observed, particularly if lambs have watery faeces.

Research at the University of Glasgow has shown the antibody responses against the larval stage of *Teladorsagia circumcincta* (an important member of the Strongyles family) can be used as a biological marker for host response to infection.

This potential phenotype provides a new way to identify genetic differences between sheep in their resistance to worm challenge. High levels of IgA (an immunoglobulin produced as part of the immune response of the sheep) have been shown to regulate both worm growth and fertility – leading to a decrease in egg output.

We cannot directly measure the amount of IgA in the intestine mucosa, but it can be detected in blood serum. AHDB-funded research has shown measures of the IgA found in blood serum can be used to predict worm resistance. Genetic influences account for 30–35% of the variation between animals, so the trait appears to be quite heritable. Differences between animals are now being exploited in Signet's sheep-breeding programmes where measurements are converted into EBVs.

Signet-recorded flocks with maternal breeds, like Lleyn and Exlana, are now routinely measuring IgA and using the EBVs produced. In 2022, a pilot study was completed with 10 hill flocks in Wales to look at the value of measuring IgA alongside FEC as part of a project to support hill farmers interested in selecting for greater resistance to worms.

The breeders' view of breeding for resistance

Tim White, member of the Sheep Improvement Group, breeding Exlana sheep

"The Exlana breeding policy is focused on reducing the labour requirements of the commercial ewe, without detriment to flock performance. Our breeders place considerable emphasis on the selection of performance-tested rams with superior worm resistance EBVs. In recent years, this has really started to pay off – a genetic benefit we are delighted to pass on to our customers."

George Cullimore, member of the Performance Recorded Lleyn Breeders

"Ram-buying clients want to purchase sheep that are both resistant and resilient to internal parasites. Signet's breeding values indicate important genetic differences between animals that have helped inform our breeding policy.

"Initial work using FEC was encouraging, but I believe the use of new phenotypes [like serum IgA] will provide the breakthrough we need to enable genetic solutions to play a greater role in worm control."

Sourcing genetically resistant rams

Selective breeding for low-FEC EBVs is practised in some Signet-recorded Lleyn, Exlana and Romney flocks, with nearly 30,000 records included within Signet's genetic evaluations.

Every month, a series of breeding values for worm resistance traits is updated and published on the Signet website, available at **signetdata.com**

Advice to commercial ram buyers:

- By using 'EBV Search' on the Signet website, you can generate lists showing those sheep within a breed with the best breeding values for FEC and IgA (**signetdata.com/sheep-search/ebv-search**)
- If you are interested in the trait, find a flock actively recording FEC and IgA
- Use the 'Accuracy Values' published alongside each EBV to indicate the degree of recording taking place
- Remember for FEC EBVs, a negative value (fewer eggs) is a positive attribute

Choosing the right product

The best worm control is achieved by using the right product at the right time. This means considering the target parasite(s), the resistance status to the different wormer groups on the farm and the animals to be treated. To minimise environmental impacts, make sure you read the instructions carefully for each product, taking note of any specific warnings regarding aquatic and soil invertebrates. Remember that a withdrawal period is not a measure of potential environmental impact.

Farms may use several wormer groups in a year. It is no longer simply a case of rotating between groups of anthelmintics on an annual basis.

Table 1 shows the five groups of broad-spectrum products that are currently available and their activity against the main worm species. The advice regarding the use of the newer groups 4-AD and 5-SI is very specific (see page 28).

Combination products contain two different wormer groups (for example, a 2-LV + 3-ML, or 1-BZ + closantel). To avoid overuse, they should only be used when it is necessary to treat liver fluke and worms at the same time. Where possible, choose a narrow-spectrum product to target specific parasites, such as liver fluke or *Haemonchus contortus*.

For more information on products, see the **Parasite control guide** which is updated annually and is available at **ahdb.org.uk**

Table 1. The five wormer groups

Group	Chemical	Spectrum	Teladorsagia and Trichostrongylus	Haemonchus	Nematodirus
1-BZ White (Group 1)	Benzimidazoles	Broad	✓	✓	✓*
2-LV Yellow (Group 2)	Levamisole	Broad	✓	✓	✓
3-ML Clear (Group 3)	Avermectin Moxidectin	Broad	✓	✓	✓
4-AD Orange (Group 4)	Monepantel	Broad	✓	✓	✓
5-SI# Purple (Group 5)	Derquantel with abamectin	Broad	✓	✓	✓
	Closantel	Narrow	✗	✓	✗
	Nitroxynil	Narrow	✗	✓	✗

* Still the preferred option for Nematodirus in young lambs, even where resistance to other worms exists

Only available as a dual active

Effective treatment

Worm control is important for lamb growth rates. Anthelmintics (wormers) are an integral part of a good worm control programme. To ensure the dose given is effective and to minimise any selection for resistance in the worm population, treatment must be given correctly.

Dose rate – weigh, don't guess

Always weigh the group to be treated and use the dose recommended for the heaviest sheep. Judging the weight by eye usually means that weight is underestimated. If there is a broad weight range, split the group and alter the dose. It is essential to accurately dose with closantel and oxyclozanide products where toxicity has occurred from overdosing. Remember to check the accuracy of the weigh crate.

Check the dose rate.

Calibrate

Equipment should be calibrated before every use, as well as during sessions in which a large number of animals are to be drenched.

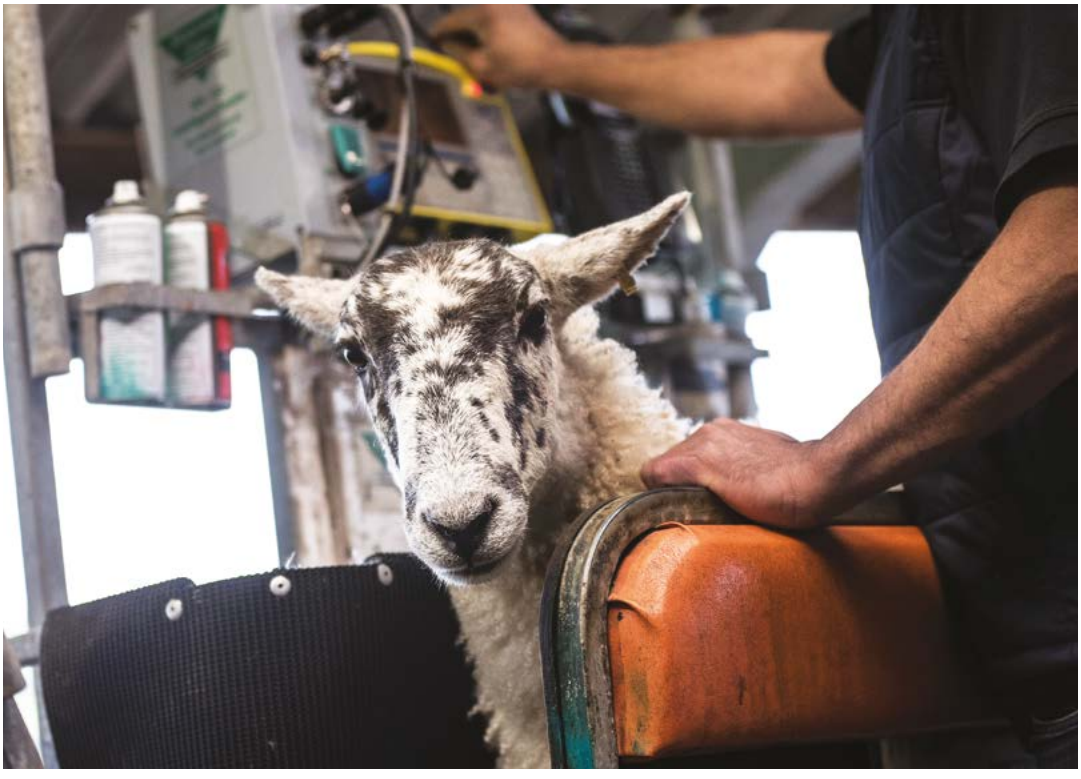
Drenching

Check the drenching gun by discharging several times into a measuring pot to make sure it is working properly and is calibrated to deliver the correct dose.

Administer correctly

Correct drenching is vital. Restrain sheep to avoid injury to the back of the throat and ensure the full dose is swallowed.

Place a hand under the head, tilting it slightly to the side. Insert the nozzle between the molar and incisor teeth so the liquid goes over the back of the tongue.



Maintain dosing guns and injectors

Clean all equipment with warm soapy water after use. Check springs and tubes to make sure there are no kinks that could allow air bubbles to form. Replace regularly for reliable performance.

Store products correctly

Keep products at 4–25°C and away from direct sunlight. Always check the use-by date. Once opened, use within the time stated on the label. Shake white group (1-BZ) products before use. Dispose of empty containers and unused products responsibly to avoid risks to the environment.

Injections

Subcutaneous injections

The product must be placed under the skin in the neck. 'Tent' the skin 10–15 cm below the ear and gently massage the site after administration. A 1.6 cm needle is recommended.

Intramuscular injections

The product must go into the muscle 10–15 cm in front of the shoulder on the neck – well above the jugular vein. A 2.5 cm needle is recommended.

Insert at a 60° angle, aiming inwards and upwards towards the head.

To find out more about administering treatment see ahdb.org.uk/knowledge-library/administering-medicine-livestock

Sheep scab

Sheep scab is an acute or chronic form of allergic dermatitis caused by the faeces of sheep scab mites (*Psoroptes ovis*). The mites are visible to the naked eye and can remain viable off the host (sheep) for 15–17 days, meaning reinfection is possible.

Before treating sheep for sheep scab, it is important to have a diagnosis. There are two ways your vet can diagnose sheep scab:

- **Skin scrapes:** Mites are collected from the skin surface of the sheep, which is a quick way to obtain a diagnosis when sheep are clinically infected. However, in the early stages of infection, it can be difficult to find mites and it is not possible to identify animals that are infected but not yet displaying clinical signs
- **Blood ELISA test:** A blood test is taken to look for antibodies the sheep produces in response to infestation. These antibodies are produced immediately, so infection can be detected as soon as two weeks following exposure

Treatment for sheep scab

There are only two options for treating sheep scab: endectocides (injectable group 3-ML) and organophosphate (OP) plunge dips (containing diazinon).

Injectable group 3-ML

The group 3-ML injectables will treat scab, but in recent years, their use has increased significantly, and this has fuelled the development of resistance to the 3-ML group in worms on many farms. To reduce this risk, it is important to avoid overuse of these products. If you have used an injectable for sheep scab control, then do not reuse for worm control in the same season. This is very important if you have used the persistent product containing moxidectin.

In addition, there are now confirmed cases of resistance in scab mites to the 3-ML products. If you use a product and think it has not worked (i.e. sheep are still itchy), you should report this to your vet or merchant. Don't just dive in and retreat.

OP dipping

OP dips must be used responsibly to ensure their effectiveness and guard against the development of resistance in the scab mites. OPs are highly toxic and must only be used under the supervision of someone holding an NPTC Certificate of Competence in the Safe Use of Sheep Dips. Container design (closed transfer systems) must be respected, instructions on dosage and administration and replenishment followed, protective clothing worn and safe storage and disposal practised.

- Follow the instructions carefully and make sure each sheep in the group is treated accurately when treating for scab
- For non-persistent products (ivermectin or doramectin), sheep must be moved to pasture that has not carried sheep for at least three weeks to avoid scab reinfection

Never use an op dip in a jetter or a shower.

It is illegal to do so because they do not get the OP down to the skin and so are ineffective. No products are licensed for us in a shower or jetter.

For further information, see **scops.org.uk/external-parasites/scab**

Mobile sheep dipping code of practice: **scops.org.uk/external-parasites/code-of-practice-for-mobile-dippers/**

Reduce the risk of sheep scab entering the flock

Quarantine all incoming and returning sheep as the first line of defence see page 32)

- Contractors/vehicles, etc. are a potential risk, so make sure they adhere to vehicle/equipment-cleaning protocols. Double fencing is useful where there is a boundary with neighbouring sheep

Figure 8. Example of double fencing

Testing the effectiveness of a wormer treatment

Detecting anthelmintic resistance in worms at an early stage allows farmers to maintain good worm control and avoid production losses associated with declining product efficacy.

Resistance develops gradually, over several years. As the efficacy of an anthelmintic group reduces, lamb growth rates are increasingly compromised until, eventually, it is obvious that worms are not being controlled. By this time, it is too late to retain any useful function for that group because resistance is irreversible.

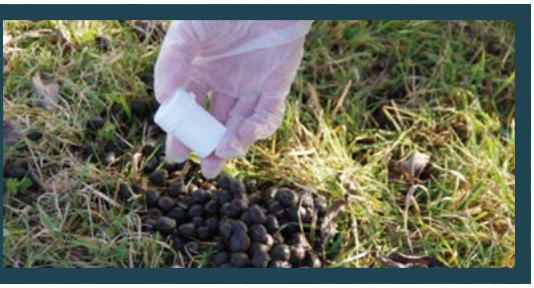
Drench test

A drench test is a practical and relatively simple way of indicating whether the wormer group being used is starting to lose effectiveness. A drench test can be done by simply taking a FEC at a specific interval after drenching (see Step 3 below). The result is much more accurate if a FEC is also carried out before treating, either before treating, to determine the need to treat, or on the day of drenching because this allows the reduction to be calculated.

Step 1
Take a dung sample before treating lambs and use a FEC to establish the initial egg count.

Step 2
Treat all the lambs in the group, taking extra care to ensure that the correct dose rate and administration technique is used (see page 22) – if not, the test results will be misleading.

Step 3
Wait for seven days (for group 2-LV yellow products) or 14 days (for group 1-BZ white or group 3-ML clear products) and re-sample the same group of treated lambs.



Is the product working?

A reduction in FEC of 90% or more means that the drench given has done its job.

For example, if the initial pre-treatment FEC was 500 eggs per gram (epg), then the post-test FEC should be no more than 50 epg.

If the value is higher, talk to your vet or SQP about changing to a different product group and what further action they would advise. Further action may include undertaking a more accurate faecal egg count reduction test (FECRT) or hatching collected larvae to establish the specific worm species involved.

How often should a test be done?

The resistance status of the various worm species will vary and different worm species dominate at different times of year. This means it is important to carry out regular drench efficacy tests throughout the year to establish what groups work best on the farm and when. Do not abandon a particular group of wormers completely until you have the full picture because there may be times when that group might still be used effectively.

The period between treatment and checking the product has worked does vary between groups. Table 2 summarises the number of days for each group.

Table 2. Post-treatment efficacy timings for all five actives

Group 1: BZ	14 days (10 for Nematodirus)
Group 2: LV	7 days
Group 3: ML	14 days
Group 4: AD	14 days
Group 5: SI	14 days

For more information, go to **scops.org.uk/internal-parasites/worms/worming-treatment-check/**

When to use 4-AD and 5-SI anthelmintics

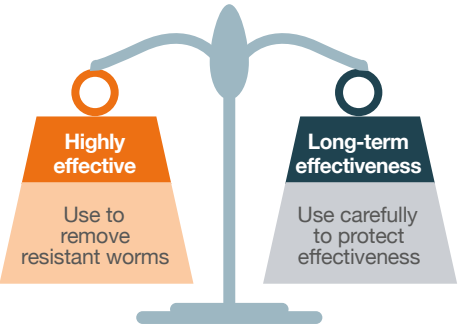
These two groups are the most recent additions to the anthelmintic range, so worms that are resistant to them are extremely rare. This makes products in these groups highly effective when used correctly and very valuable in worm control programmes.

However, it is important to strike a balance. We need to harness the effectiveness of these two newer groups to help us sustain the older products but, at the same time, protect them from overuse and the risk of developing resistance.

Striking the balance

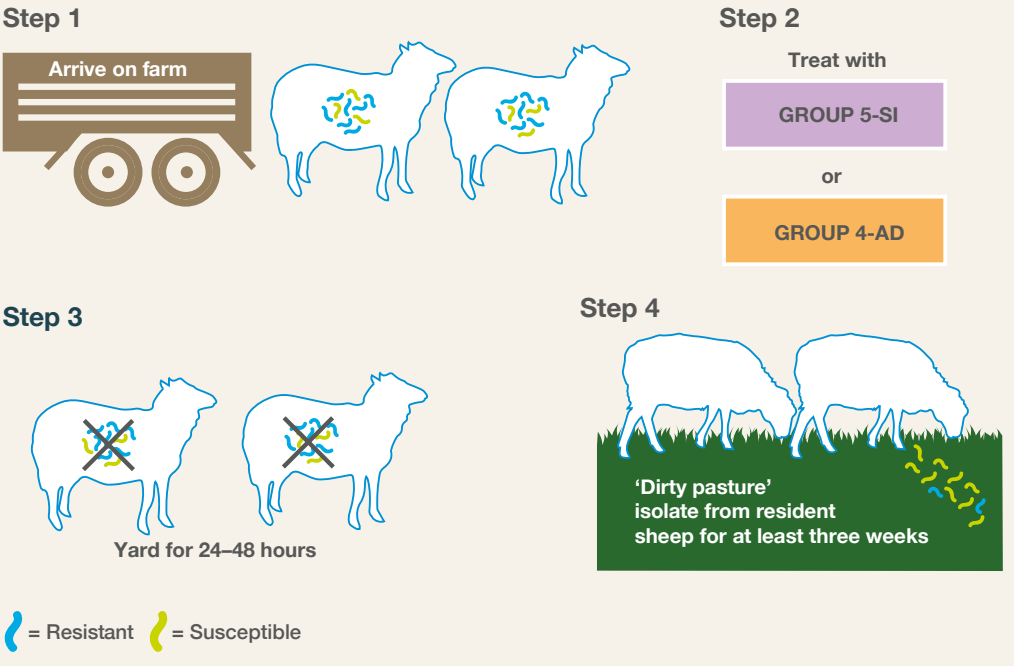
To achieve this balance, there are only two occasions when one or other of the group 4-AD or 5-SI anthelmintics should be used:

- As a quarantine treatment to ensure any worms that are resistant to the older groups are removed and not brought onto the farm
- As a single treatment for lambs in the mid-to-late grazing season to remove worms selected for resistance to the three older groups through doses given earlier in the season



Quarantine drench

Using either a 4-AD or 5-SI for all incoming sheep prevents the sheep from bringing resistant worms in from another farm (see below).



Mid-to-late-season treatment for growing lambs

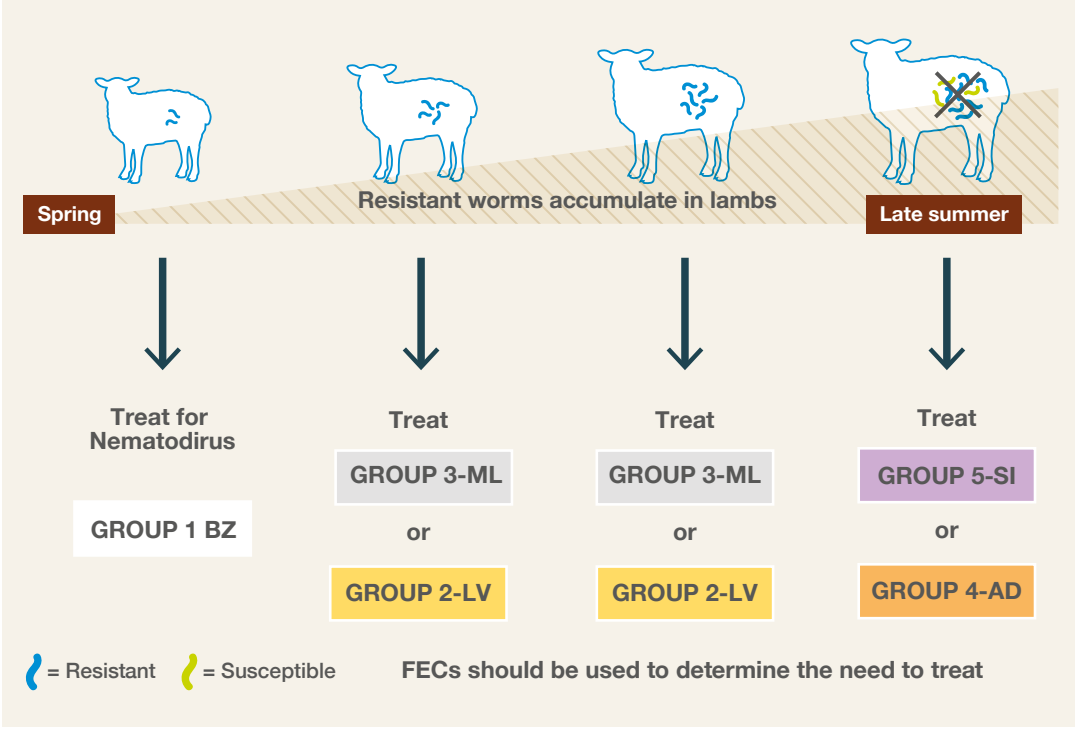
When a FEC indicates the need to treat, then using 4-AD or 5-SI products as a single 'one-off dose for all lambs' on the farm later in the grazing season has two important benefits:

- Improved lamb performance, because all the accumulated worms in the gut that have survived previous treatments are killed
- Killing worms means they cannot breed, so do not add their resistant genes to the farm's worm population. This helps slow the development of anthelmintic resistance to other groups

The diagram below illustrates how this works in a typical situation in which lambs on permanent pasture, which were treated for Nematodirus in the spring, then received another two treatments when FECs were high.

Remember – do not 'dose and move'

Never worm lambs and then move them immediately on to 'clean' grazing or areas with very low worm burdens (e.g. aftermaths and new leys) after treatment. Leave them where they are for four to five days and then move. This makes sure they do not only take worms that may be resistant to the group 4 or 5 product with them.



Case study

Emlyn Roberts, North Wales – Strategic use of group 4 product

Emlyn Roberts and his family farm in North Wales on a 1,136 acre (460 ha) hill farm. The farm runs 35 Welsh Black cattle and 830 Welsh ewes on a closed hill. The aim of the farm is to produce a hardy Welsh ewe to breed lambs that can thrive and produce a good-quality carcase on the mountain land with minimal input. The sheep flock is run as a closed flock, with the exception of buying in rams.

The family are members of the Flock Health Club with their farm vet practice in Dolgellau and are also part of the HCC's Red Meat Development Programme's flock and herd health planning project, Stoc+. These initiatives identified that one of the key health concerns of the farm was the need to review products used to treat worms in the sheep flock.

There were two main areas to focus on this farm: ewes returning from winter grazing and growing lambs in mid-season.

Previously, the farm predominantly used a white drench routinely and regularly through the grazing season with the lambs. A faecal egg count reduction (FECRT) test revealed resistance to the white worm drench (group 1). This resulted in a change in product use to groups 2 or 3 during the season. A white drench is still used to effectively tackle early-season Nematodirus, but all subsequent drenching is based on faecal egg counts (FECs) rather than routine treatment for finishing lambs.

Fewer, more strategic treatments are now used, including the introduction of a mid-season group 4 orange product. In order to reduce the risk of further resistance to other groups and retain the efficacy of the group 4 product, this treatment is only utilised when there is a high faecal egg count in the lambs. Emlyn is keen to ensure that his sheep don't carry resistant worms and regularly monitors this using advice from the vet.

Ewe lambs are away-wintered and return to the farm in the spring. Before the review of worm control in the health plan, these sheep were returned to the main flock untreated. The policy has now changed to introduce a 'quarantine' treatment of group 4 to these sheep to protect the rest of the flock from any incoming resistant worms and worm burdens. Bought-in rams are also routinely quarantined and drenched with group 4 orange product before mixing with his flock.

As a result of health-planning initiatives, the drenching protocol has become more structured and based on the results of faecal egg counts. Strategically alternating the wormer groups has helped to reduce the number of drenches used overall, but to achieve this there was a need to introduce a new quarantine drench.

It was the regular reviews of the farm's animal health plans and use of FEC to reveal resistance to white drench that prompted Emlyn to review the strategy for worm control in the sheep flock and to include groups 4 and 5 for returning ewes and mid-season drench for finishing lambs.

*The Red Meat Development Programme is a five-year strategic initiative funded through the Welsh Government Rural Communities – Rural Development Programme 2014–2020, funded by the European Agricultural Fund for Rural Development and the Welsh Government.

Quarantine

Effective quarantine and treatments will remove any resistant roundworms carried by incoming sheep and reduce the risk of them bringing in sheep scab.

Table 3. Effective quarantine and treatments of roundworms, sheep scab and liver fluke

Step	Timeline	Roundworm
1 **Assess risk** - Roundworm - Sheep scab - Liver fluke	At purchase (day 0)	Assume all animals are carrying resistant roundworm infections.
2 **Treat** Yard or house animals for 24–48 hours and administer quarantine treatment within this time.	Sheep arrive on farm (day 0–2)	Treat for resistant roundworms. See page 34 for treatment information.
3 **Isolate** Turn out onto pastures grazed previously by resident flock for 3–4 weeks.	Days 2–28	Keep all incoming sheep isolated from the rest of the flock. Turn out separately onto pastures grazed previously by resident flock (where available) for 3–4 weeks. (days 2–28).
4 **Test** Ensure treatment was effective. Is scab a possible risk?	Days 7–21	Test anthelmintics have worked. Faecal egg counts 14 days after treatment.
5 **Rejoin flock** Join the rest of the flock.	After 21–28 days	Animals can join home flock.
6 **Re-treat** Re-treat for liver fluke if necessary.	Days 35–43	Repeat treatment if liver fluke risk identified.

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Assess your sheep scab risk

Low scab risk: Sheep where vendor states they have been treated or where animals have been away grazing and not in contact with other sheep.

High scab risk: Untreated animals from a farm with a known risk, e.g. common grazing or from a farm/mart in a hotspot area (see manual for more details). If in doubt, choose the high-risk category.

Sheep scab	Liver fluke
Assess if sheep scab risk is high or low.	Assess liver fluke risk. See page 35 for guidelines on liver fluke risk assessment.
High scab risk: Isolate and test to inform the need for treatment or treat immediately and isolate. **Low scab risk:** Isolate and test to inform the need for treatment (step 4). See page 34 for treatment information.	Assume liver fluke are triclabendazole-resistant. See page 35 for treatment information.
Test for exposure to sheep scab mites (ELISA test) 14 days after sheep arrive on farm. Sheep scab ELISA test (14 days post-purchase). Treatment if ELISA test is positive.	Faecal egg count (21 days post-treatment). Coproantigen ELISA.

Treatment options

For sheep scab, actions and treatment options are based on an initial risk assessment.

Choose your scab risk category and then either a gold, silver or bronze options and carry out all the treatments shown in that list. Worming treatments can be selected from gold (both a 4-AD and 5-SI wormer), silver (either a 4-AD or 5-SI with moxidectin) or bronze (a 4-AD or 5-SI only).

Ensure all treatments are administered on arrival. All treatment options assume that anthelmintic-resistant nematodes are present and treatment is included.

Low scab risk/roundworm

Active ingredient	Gold	Silver 1	Silver 2	Bronze 1	Bronze 2
4-AD	✓	✓		✓	
5-SI	✓		✓		✓
Moxidectin (oral drench)		✓	✓		

Test after 14 days for sheep scab by etiher skin scrape or ELISA blood test.

High scab risk

Active ingredient	Gold 1	Gold 2	Silver 1	Silver 2	Silver 3	Silver 4	Bronze 1	Bronze 2
4-AD	✓	✓	✓		✓		✓	
5-SI	✓	✓		✓		✓		✓
Moxidectin (oral drench)			✓	✓				
Moxidectin (injection)		✓			✓	✓		
OP dip	✓		✓	✓				
Doramectin (injection)*							✓	✓

*Turn to pasture not grazed by sheep for at least 15 days treatment

Test negative for scab

No further treatment required

Test positive for scab

Discuss treatment options and potential treatment failures with your vet or suitably qualified person (SQP). If your initial product choice is not sucessful in treating the sheep scab, use an alternative active ingredient in your next product. See Table 4 for information on active ingredients. **The Parasite control guide** has more information on treatments.

Table 4. Active ingredients and their method of application

Active ingredient	Method of application
Diazinon	Plunge dip
Ivermectin	Injection (2 doses required)
Doramectin	Injection
Moxidectin 1%	Injection (2 doses required)
Moxidectin 2%	Injection

Risk assessment for liver fluke

Risk from liver fluke (and drug resistance) in bought-in sheep should be considered where:

- Animals are being purchased from a farm where liver fluke has been identified
- Animals are being purchased from a farm with unknown fluke infection status, in particular:
  - Farms with, or close to wetland habitats and/or farms with limited drainage
  - Farms in areas with high annual rainfall
- If buying-in animals in autumn/early winter, animals could be at risk of acute disease

High liver fluke risk

Active ingredient	Repeat treatment is recommended#
Closantel	6 weeks later
Nitroxynil	7 weeks later
Triclabendazole	Closantel or Nitroxynil 7 weeks later

Repeat treatment is recommended even if 21 days FEC/coproantigen is negative.

Liver fluke advice is currently tailored for liver fluke and not rumen fluke, only consider rumen fluke treatments if you see clinical signs and consult your vet.

Find more information on assesment and treatment of liver fluke, see the **Liver fluke control in grazing livestock** manual.

Assessing and reducing pasture risk

Although anthelmintics are a key part of worm control in most systems, research shows that even lambs that are drenched when required with a fully effective anthelmintic grow half as well as lambs with no challenge.

Where sheep are the only livestock, avoiding high worm burdens can be challenging. However, there are options to graze lower-risk pastures, such as hay and silage aftermaths, or to use dry, mature ewes to 'hoover' larvae off infected pasture. See Table 5 for examples.

Table 5. Examples of situations of high-, medium- and low-risk pastures

Season	High	Medium	Low
Spring	Ewes and lambs grazed in the previous year High risk of Nematodirus if pasture carried ewes and lambs in the previous spring Goats grazed the previous year Store/ewe lambs grazed the previous autumn/winter	Grazed only by adult non-lactating sheep the previous year Grazed by ewes and lambs the previous spring, but then conserved and aftermath not grazed by sheep (Note: Nematodirus still high risk)	New leys or forage crops Grazed by cattle or cut for silage or hay in the previous year (no sheep)
Summer	Ewes and lambs grazed in the spring	Grazed only by adult non-lactating sheep in the spring Grazed by cattle or cut for silage or hay in the spring	Grazed by cattle or cut for silage or hay only in the first half of the grazing season Forage crops or arable by-products grown
Late season/ autumn	Stocked with ewes and lambs all season	Grazed by cattle since mid-season Grazed by fit, mature, dry ewes since weaning mid-season	Grazed by cattle or cut for silage or hay only in the first half of the grazing season Forage crops or arable by-products grown

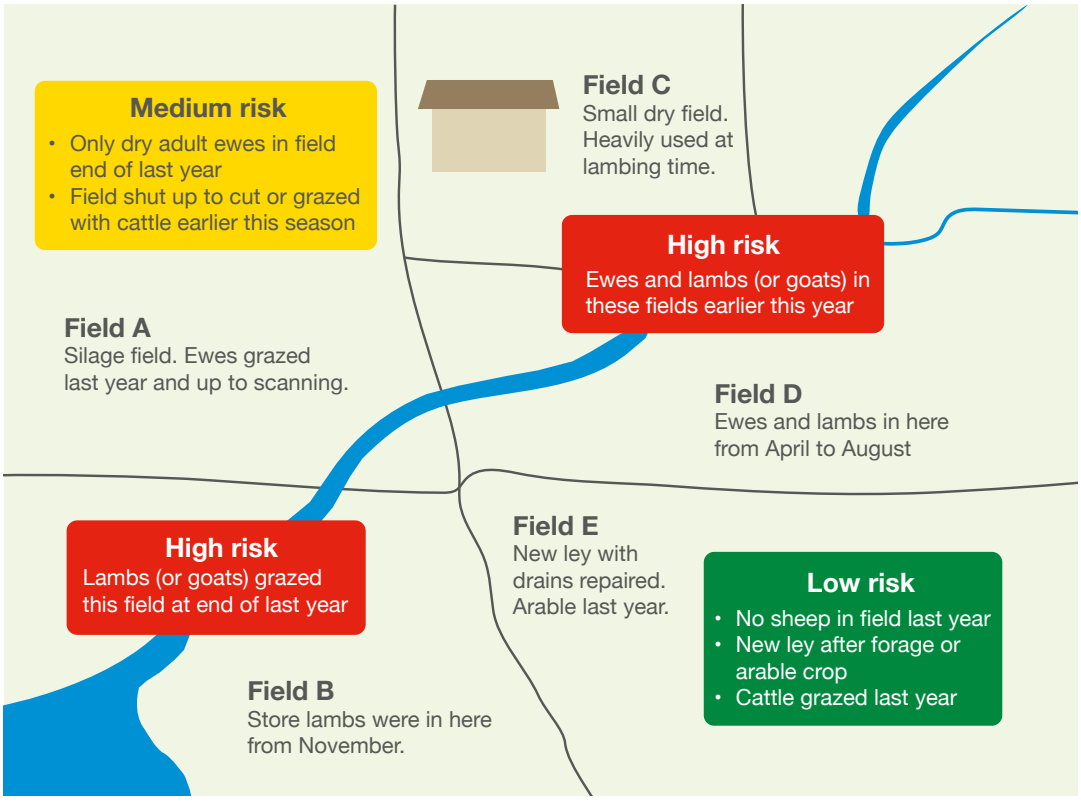
Risks vary in different fields across the farm

By using the farm map to identify which fields have held which class of stock over the last 12 months, it is possible to highlight the level of risk in each field, as shown in the example below.

With careful planning, the risk associated with each field can be reduced for vulnerable stock. Strategies to achieve this can be as simple as ensuring that ewes and young lambs are not spread across the whole farm.

Never ‘dose and move’

Worming lambs and then moving them immediately on to ‘clean’ grazing or areas with very low worm burdens (e.g. aftermaths and new leys) is extremely selective for resistance. To minimise this risk, you can either worm them and leave them where they are for four to five days and then move or use the targeted approach and leave a proportion (at least 10%) of the best lambs untreated.



Grazing and management tools

There are actions we can take to try to reduce lambs' exposure to high worm burdens.

Good-quality grazing needed for high lamb growth rates also improves resilience to worms during the season. Maintain optimum sward heights and avoid grazing below 4 cm to reduce the number of infective larvae ingested from the base of the sward.

Grouping lambs by age at turnout makes treatment and management decisions more accurate and FECs more meaningful for the group.

Weaning is an important management tool, allowing lambs to be moved to lower-risk grazing, such as aftermath, to avoid the high challenge that has built up on pastures they have been grazing with their mothers. Consider weaning at 10–12 weeks if low-risk, quality grazing is available.

Mixed grazing with cattle reduces pasture contamination through lower sheep stocking density, although it is harder to achieve efficient grassland utilisation, as targets for each species are different. Rotating cattle and sheep grazing is another way to dilute the worm burden.

Use dry ewes post-weaning to reduce larval levels on heavily contaminated pastures. Ewes in good body condition will ingest infective larvae, killing many of them off. This reduces the larval levels on the pasture and in particular the numbers overwintering until the following spring. (This does not apply to Nematodirus.) Monitor ewe FECs to ensure they are not dropping many eggs in their dung.

'Bioactive' crops, such as chicory or bird's-foot trefoil and sainfoin, are also options to reduce worm challenges for weaned lambs. Swards containing plantain, chicory and significant amounts of clover will also improve protein nutrition and reduce the negative effects of worms on lambs.

Forage crops provide low-risk grazing for lambs in the autumn. There are increasing opportunities within arable rotations; for example, for green cover crops.

Checklist for improving worm control

	Page number
Is worm control a key part of the animal health plan you have drawn up with your vet?	11
Do you check that you are using the right product?	21
Do you take regular FECs and utilise them, alongside other information, to decide when to treat with a wormer?	34–35
Do you always treat correctly and at the right dose rate?	28–29
Do you avoid highly selective ‘dose and move’ actions?	36
Have you checked a wormer has worked (killed >90% of the eggs) after treatment?	26–27
Do you have an effective quarantine strategy in place?	32–33
Do you know the anthelmintic resistance status on your farm to the three older groups of wormers: 1-BZ, 2-LV, 3-ML?	5–6
Do you incorporate the new actives (groups 4 or 5) into your current worm control programme?	4–5
Do you utilise ewe body condition score (BCS) in adult sheep to determine the need to worm pre-tupping and/or pre-lambing?	16
Could you weigh lambs and use their growth rates, in combination with FEC/ pasture risk, to target dosing where it is needed? (TST)	11–13
Have you assessed the different levels of pasture risk across the farm and matched lower-risk areas to the most vulnerable stock?	36–37
Could you include clovers or bioactive forages, like chicory or sainfoin, in any of your new leys for grazing sheep?	38
Do you have a sustainable plan to protect your flock against sheep scab?	

Further information

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