Liver fluke disease in sheep and cattle

Nationally, an estimated 40 million sheep and 6 million cattle graze on pastures where liver fluke is endemic. Graziers spend approximately $10 million a year on fluke drenches alone; and lost production costs a further $50–80 million a year.

Deaths account for only a part of this loss. Other significant losses in sheep include:
• reduced production and quality of wool
• reduced lambing percentages
• poor growth rate of lambs
• reduced culling percentages, and increased costs for replacement stock.

In cattle, losses include:
• reduced production and quality of milk

Distribution of liver fluke disease in different climatic regions.

Liver fluke (Fasciola hepatica) from sheep.
The adult flukes in the bile ducts produce eggs which are passed in the faeces (a).

The eggs hatch when separated from faecal material in wet areas, under optimal conditions.

The first larvae or miracidia released (b) invade the lymnaeid snails in which they develop and multiply as sporocyst, rediae and cercariae (c).

The tadpole-like cercariae leave the snails (d) and swim until they encyst on vegetation, forming metacercariae (e), which are the infective stage of the fluke. The entire cycle of the liver flukes in the snails takes two to three months under favourable conditions in the field.

If the metacercariae are ingested by sheep, cattle or other hosts, including people (f), the metacercariae excyst in the small intestine and the released immature flukes penetrate the intestinal wall into the abdominal cavity. The young flukes penetrate the liver capsule and migrate through the liver tissue for six to seven weeks before entering the bile ducts to become adult flukes (g).

The flukes reach sexual maturity and commence egg production at eight to ten weeks after infection.
The introduced Lymnaea columella and its egg mass with embryos (shell 16 mm long).

EPIDEMIOLOGY
The two primary requirements for the establishment of liver fluke are a suitable snail (the intermediate host) and an environment that suits the fluke eggs, the snails and the larval fluke—such as springs, slow-moving streams with marshy banks, irrigation channels and seepages.

In Australia, the most important intermediate host is the indigenous freshwater snail, Lymnaea tomentosa. An introduced North American snail (L. columella) and an introduced snail from the Pacific area (L. viridis), found in defined locations of the NSW coast, have been recently identified as additional intermediate hosts.

The fluke eggs are passed in the faeces into wet areas. Here they hatch, when mean temperatures increase to above 10°C (mostly from mid-September to May). In summer, the eggs take approximately 21 days to develop into miracidia; in the spring and autumn, hatching can take up to 90 days.

The larva (miracidium) invades the snail, where it develops and multiplies. One single miracidium hatching from a fluke egg can produce up to 4,000 infective cysts (metacercariae). These cysts attach to grass and other vegetation. In the presence of sufficient moisture the metacercariae will remain alive for many weeks, depending on the temperature. They survive longer at below 20°C; higher temperatures and desiccation will destroy the metacercariae in a short time.

The snails, acting as intermediate hosts, produce eggs throughout the year. These eggs hatch when the temperature is right. There is a marked increase in reproduction from spring to late autumn. Snails may produce 3,000 eggs a month and one generation of snails from egg to egg takes only about one month under optimum conditions. Lymnaea tomentosa survives in dry mud for at least one year, and tolerates low temperatures. The snail can move with and against the water current for long distances.

The larval stages of fluke (sporocysts, rediae) also survive in those snails for long periods, and resume development when climatic conditions improve.
graze in the wet marshy areas favoured by the fluke snail, so the eggs are deposited in a suitable environment. If food is available elsewhere, sheep and goats prefer to graze away from marshy pastures. Long wet seasons are usually associated with a higher infection rate but sheep are more likely to ingest large numbers of cysts during dry periods after a wet season, when the animals are forced to graze in swampy areas, resulting in heavy infection.

**LIVER FLUKE DISEASE**

**Acute fasciolosis**

There may be an outbreak of the disease following a massive but relatively short-term intake of metacercariae. The high intake is the result of certain seasonal and climatic conditions combined with a lack of fluke control measures; typically, stock forced to graze in heavily contaminated wet areas as a result of overstocking and/or drought.

Animals suffering from acute fasciolosis may not show any obvious symptoms. Some animals may show abdominal pain and may become jaundiced.

Death is usually due to blood loss resulting from haemorrhage in the liver. The liver haemorrhage is the result of the immature fluke burrowing through the liver.
Subacute fasciolosis
Subacute fasciolosis is characterised by jaundice, some illthrift and anaemia. The burrowing fluke causes extensive tissue damage, leading to haemorrhaging and liver damage. The outcome is severe anaemia, liver failure and death in 8–10 weeks.

Chronic fasciolosis
Chronic fasciolosis is the most common form of liver fluke infection in sheep, goats and cattle - and particularly in more resistant hosts, such as horses and pigs. It occurs when the parasites reach the bile ducts in the liver. The fluke ingests blood, which produces severe anaemia and chronic inflammation and enlargement of the bile ducts. The clinical signs develop slowly. The animals become increasingly anaemic, appetite is lowered, the mucous membranes of the mouth and eyes become pale and some animals develop oedema under the jaw ("bottle jaw"). Affected animals are reluctant to travel.

Black disease
Black disease is an acute and fatal liver disease which can affect sheep and cattle. It is usually associated with the liver damage caused by the migrating young fluke; the damage provides a suitable environment for the germination of spores of Clostridium novyi type B bacteria in the liver. (See Agfact A3.9.30 Black disease.)

Parasite-Host relationship
In sheep, there is no evidence of any acquired resistance against Fasciola hepatica. Acute and chronic fasciolosis can occur at any age.

Cattle have a natural resistance and under normal conditions the clinical disease is only likely in young cattle.

Chronically infected cattle can spontaneously recover, and previously infected animals can partially resist re-infection. However, this resistance is only possible because of chronic fibrotic changes in the liver, so with even a small number of fluke present, there may be production losses.

Sheep with pale conjunctiva of the eye, due to anaemia.

Sheep with bottle jaw (oedema) due to chronic fasciolosis.

Calf with bottle jaw.

Diagnosis
Fasciolosis should be considered when there are cases of death, anaemia or illthrift in sheep or cattle grazing on fluke-prone country.

In the live animal, chronic fasciolosis is indicated by fluke eggs in faecal sample.

A dead animal can be quickly diagnosed by the presence of mature or immature fluke in the liver; the necropsy will also identify any other conditions that may be contributing to the problem. A serological test (ELISA) is also available for fasciolosis. It detects infection with both immature and adult fluke in a flock or herd, but it is not sensitive enough for diagnosis in individual animals.

TREATMENT
The treatment recommended will depend on the nature of the disease. Some of the available anthelmintics are not effective against immature...
Sheep liver with severe acute infection.

Sheep livers with advanced immature fluke causing haemorrhages (subacute fasciolosis).

Sheep liver with migration tracks due to early immature fluke (acute fasciolosis).

Fibrous perihepatitis caused by migrating immature flukes (top). Adhesions due to fibrous perihepatitis (bottom).

Fatal acute fasciolosis: numerous migrating immature flukes cause fatty degeneration and fibrosis.
Sheep liver with chronic fluke infection, indicated by numerous adult flukes in the enlarged bile ducts (top). Sheep liver with moderate chronic fluke infection (bottom).

Severe chronic fluke infection with massive fibrosis in sheep (top). Cross section of a fibrotic sheep liver with heavy chronic fluke infection (bottom).

Calf liver with serious fibrosis due to heavy infection (top). Cross section (bottom).

Below: Calcified bile duct, adult flukes (cattle).
fluke and so are not recommended in acute fluke outbreaks. Also, they are less efficient for the strategic control of fasciolosis. The best control and chemoprophylaxis can be achieved with drugs effective against early immature and adult fluke, such as triclabendazole.

Table 1 summarises the efficacy of drugs registered for treatment of fasciolosis in sheep and cattle.

**STRATEGIC CONTROL**

Due to the great biotic potential of *Fasciola hepatica* and their intermediate host snails, only a continuous and coordinated strategic application of all available measures can provide economic control of the disease.

Control should be on a preventive rather than a curative basis. For effective control:

- use strategic anthelmintic treatment, to reduce the number of fluke in the host and the number of fluke eggs in pasture
- reduce the number of intermediate host snails
- manage fluke-prone areas, to reduce exposure to infection.

These three strategies are detailed as follows.

**USING ANTHELMINTICS**

The first of these strategies is the use of anthelmintics, based on the epidemiology of the disease. This makes it possible to determine the time of the year when the maximum effect can be achieved with the fewest possible treatments.

The correct time for anthelmintic treatment depends mainly on climatic conditions and weather data (which is available from many districts). Timing is basically similar across districts, with only small adjustments required in south-eastern Australia.

Figures 2–4 suggest strategic treatments for the Central Tablelands, the Northern Tablelands and the North Coast. The weather pattern of the Central Tablelands (Figure 2) is similar to that of the Southern Tablelands. The North Coast pattern (Figure 4), apart from higher rainfall, is similar to conditions in the south coast. (Copies of program charts for other districts are available from the author on request. Pay attention to the great differences in rainfall between charts.)

In the irrigation areas a similar program is recommended where the epidemiology of fasciolosis depends mainly on temperature.

Treatments are essential when clinical disease

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**Table 1. Comparative anthelmintic efficiency and safety of drenches suitable for the treatment of fasciolosis in sheep and cattle.**

<table>
<thead>
<tr>
<th>Active ingredient</th>
<th>Safety Index* at recommended dose</th>
<th>Over 90 per cent Efficiency at Recommended Dose</th>
<th>age of fluke (weeks)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>triclabendazole</td>
<td>20</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>closantel †</td>
<td>5.3</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>closantel †</td>
<td></td>
<td>plus oxendazole</td>
<td>5.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>closantel † plus albendazole</td>
<td>5.3</td>
</tr>
<tr>
<td>nitroxynil §</td>
<td>4.0</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>albendazole</td>
<td>6.0</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>oxyclozanide ‡</td>
<td></td>
<td>plus levamisole</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>closulon § plus ivermectin</td>
<td>20</td>
</tr>
</tbody>
</table>

**KEY**

* Safety Index = Maximum tolerated dose

† Not registered for cattle

‡ Registered as a subcutaneous injection for cattle

§ Registered as a subcutaneous injection for cattle

§ At 12 weeks is less effective in cattle than in sheep

**Registered for lactating cows**
is apparent, even though it may be too late to prevent economic losses. Treat according to the charts in order to prevent the disease and reduce the problem of liver fluke disease to a manageable level.

Drugs play an important role in the control of fasciolosis. An efficient strategic control program relying on a minimum number of annual treatments and aimed at long-term elimination of pasture contamination requires drugs that are effective against both mature and early immature flukes. More frequent treatments are necessary if you use drugs that are only effective against advanced mature fluke aged 12–16 weeks or older.

Sheep

Some of the anthelmintic treatments for sheep can be readily integrated into the WormKill and Drenchplan programs, with some adjustment (see Table 2 - next page).

The closantel drench used in the WormKill program is effective against young mature fluke aged about six to eight weeks, but has reduced effect on early immature fluke populations. This problem is more pronounced since the emergence of closantel resistance in immature *F. hepatica*. The closantel plus oxfendazole combination has good synergistic efficacy against fluke aged four weeks and can be successfully used against fluke resistant to triclabendazole.

Closantel, or the above combination, is suitable for the late winter/early spring treatment (see Table 2).

The recommended treatments are:

- **Late winter/early spring.** Preventive treatment of all cattle and sheep at this time reduces pasture contamination before the snails and fluke become active. Otherwise, the contamination of pastures with fluke eggs will result in high fluke burdens in late spring and summer.
- **Summer.** The larvae that infected snails in the previous autumn resume their development as temperatures increase (overwintering infection). A fluke drench in January is necessary to eliminate the fluke picked up in the late spring and early summer. This treatment can be delayed until February to coincide with Wormkill or Drenchplan; use a drench that is effective against early immature fluke - triclabendazole - because of the additional build-up of fluke during the summer months.
- **Autumn.** The peak output of infective cysts is
TABLE 2 Control programs which combine anthelmintic treatments and farm management practices.

**WormKill Integrated Worm Control program for Sheep in the New England Region**

<table>
<thead>
<tr>
<th>Date</th>
<th>Grazing Management</th>
<th>WORMTEST</th>
<th>ADULTS AND HOGGETS</th>
<th>LAMBS and WEANERS</th>
<th>ALL SHEEP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Closantel</td>
<td>Closantel</td>
<td>Extra fluke control</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>or closantel</td>
<td>or closantel</td>
<td>control triclabendazole, or closantel+</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>combinations</td>
<td>combinations</td>
<td>oxfendazole*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Effective broad</td>
<td>Effective</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>spectrum</td>
<td>spectrum</td>
<td></td>
</tr>
<tr>
<td>Late August</td>
<td>Preparation of first LOW-WORM (weaner) pasture is underway</td>
<td>ewes</td>
<td>(○)</td>
<td>(○)</td>
<td>(○)</td>
</tr>
<tr>
<td>pre-lambing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid-Sept lambing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid-Oct marking</td>
<td>Preparation of second LOW-WORM weaner pasture is underway</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>ewes and lambs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early Nov</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Late Dec weaning</td>
<td>Drench and move weaners to first LOW-WORM pasture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Late Feb</td>
<td>Drench and move weaners to second LOW-WORM pasture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Late March/April</td>
<td></td>
<td>all sheep</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>April/May</td>
<td>Drench and move weaners again if possible</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>June/July</td>
<td></td>
<td>weaners</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DrenchPlan Integrated Worm Control Program for the Central and Southern Highlands, Monaro, South West Slopes and Irrigation Areas**

<table>
<thead>
<tr>
<th>Date</th>
<th>Comments</th>
<th>Grazing management</th>
<th>WORMTEST Adults and Hoggets</th>
<th>Lambs Weaners</th>
<th>Added Barber’s Pole Control</th>
<th>Fluke Control all sheep</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late Winter</td>
<td>Preparation of first LOW-WORM pasture for weaners is underway</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>or Early Spring</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-weaning</td>
<td>Drench and move weaners at start of weaning</td>
<td>Preparation of second LOW-WORM pasture for weaners is underway</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nov/Dec</td>
<td>Pastures are haying off</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feb</td>
<td>Second summer drench</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hot, dry - this drench may be unnecessary in dryer areas (350-500mm rainfall) and seasons</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>all classes of sheep</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>April</td>
<td>Drench required (○)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>July</td>
<td>Drench required (○)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* drench required (○) drench may be required depending on area, season and results of WormTest.
* Alternate use of the products is recommended, changing annually in late August. This regimen may delay development of resistance.
These two dam sites are typical snail habitats. Snails may be in the edge of the dam near the outflow (right) or in the overflow during rainy periods (above).

during late summer/early autumn (summer infection). Use a drench that is effective against early immature fluke - triclabendazole. This controls clinical disease and reduces pasture contamination.

The best time for this treatment is April/May, which may coincide with Drenchplan or Wormkill.

Summer rainfall areas in the northern Tablelands and North Coast may need another treatment in July after a wet summer.

• **Winter.** If you have used chemicals that are not effective against immature fluke, another fluke drench is necessary in June/July. This removes the fluke that survived the April drench when they were still at the immature stage. (As noted earlier, drug resistance can sometimes reduce the efficacy against flukes.)

Triclabendazole is very effective against both early immature and adult fluke. If this drug is used then good control may be achieved with only three treatments a year.

These treatments are given as follows:

• **August/September,** to remove fluke carrying over from late autumn and winter, and to prevent pasture contamination.

• **January/February,** to eliminate fluke picked up during the late spring and early summer.

• **April/May,** to eliminate fluke picked up during summer and early autumn.

Using triclabendazole more frequently (such as every three months from September) reduces fluke disease to a negligible level. However it has to be a continual program if new stock are to be introduced or if there is likely to be reinfection from streams coming from neighbouring paddocks. Also, more frequent drenching may lead to development of drug resistance.

Drug resistance in liver fluke to triclabendazole has been reported in a few farms. The development of resistance may be delayed by alternating use of triclabendazole with a closantel plus oxfendazole combination - changed annually. A closantel plus oxfendazole combination is good as an alternative drench due to its synergistic effect against liver fluke.

**Beef cattle.** Cattle are more resistant to fluke infection than sheep. Adult cattle require fewer treatments to control fasciolosis. The recommended treatments are as follows:

• **August/September,** to eliminate fluke before
This is a typical snail habitat in the North Coast hills.

spring, when the conditions become favourable for fluke eggs and host snails. This is an essential treatment for all cattle. It is advisable to treat cattle and sheep at the same time.

- **February**, an additional treatment for all young cattle.
- **April/May**, another important treatment for all cattle, to eliminate any fluke picked up during summer.

**Dairy cattle.** Treat young heifers and dry cows with a drug effective against immature fluke - triclabendazole - and follow the above plan for beef cattle.

The only drug registered for use in lactating cows is only effective against the fully grown adult fluke (aged 14 weeks or older). It is a combination of oxyclozanide plus levamisole. If your property is heavily contaminated, you may have to treat lactating cows monthly during summer and autumn, using this product, which also controls gastrointestinal nematode and lungworm infections.

You will improve fasciolosis control with a triclabendazole treatment a month before calving, and immediately after drying off.

**Mixed grazing.** Be careful if sheep and cattle are grazing on the same pasture, whether together or alternately: you may need to treat your cattle every time you treat your sheep, to reduce or eliminate contamination of pastures and thus infection. For best results use a drug highly effective against early immature fluke, ie triclabendazole, or against advanced immature fluke, ie nitroxynil.

**INTERMEDIATE HOST SNAIL CONTROL**

This is the second available strategy for control of *Fasciola hepatica*.

**Chemical control**

It is unlikely that chemical control or biological means will eradicate the snail population, because it reproduces so readily; rapid repopulation can follow effective treatment. Chemical control of snails should aim, therefore, at reducing the number of infected snails rather than eradicating them.

A spring treatment reduces the number of snails before they begin rapid reproduction. A second treatment in late summer or autumn kills the snails infected with fluke larvae.

Many properties are unsuited to the application of molluscicides, and most chemicals are toxic to the environment. Effective use of chemicals requires specialist advice, cooperation with neighbours and much labour.

There is no product registered for snail control in Australia. Bluestone copper sulphate has been used at the rate of 5 parts per million, calculated for assessed water volume. It is safe for the environment.

**Improved drainage**

Irrigation projects provide the snails with ideal habitats. Regular clearing of vegetation from drainage channels may reduce silting and blockages that normally support snail-contaminated herbage.

Seepages from irrigation channels often harbour large snail colonies. In low-lying areas, adequate drainage would prevent accumulation of water. Snails multiply for extended periods in wet, low-lying areas. Draining marshy pastures and building dams may reduce snail habitats and increase grazing areas.

**DISEASE CONTROL BY FARM MANAGEMENT**

This is the third available strategy for control of *Fasciola hepatica*.

**Fencing**

On many properties, the snail-infested pastures occupy only a small part of the animals’ grazing area. Fencing off these contaminated areas is a most economic and efficient method of controlling fasciolosis. Spending a few hundred dollars on fencing may prevent a serious outbreak of liver fluke disease.
Snail habitat in the South Coast (Jamberoo).

Irrigation channel and shallow drainage area
Grazing management

The number of animals needing fluke drench could be reduced by more attention to grazing management. Identify the snail-infested pastures on the property; only those animals grazing these areas need treatment.

A rotational grazing program was once recommended in Australia to eliminate infection, but unfortunately the system was never used in the field by our farmers.

The theory was to, firstly, apply an effective drench before moving stock to potentially contaminated areas. The second step was to alternate the grazing between the potentially fluke-infected areas and the fluke-free areas. Grazing in infected areas would be for less time than it takes the fluke to reach maturity and produce eggs (six weeks). Grazing would be for longer periods in fluke-free areas; here, any fluke picked up on the fluke-infested paddocks would reach the adult stage but would be removed by drenching about two weeks before stock moved back to contaminated pastures.

The major objection was the difficulty in organising pasture rotation and the problems of moving fences or erecting new fences.

However, the system could be easily applied to many properties where only a small number of paddocks have suitable snail habitats.

In mixed grazing properties the more resistant cattle could be grazed on the known fluke-prone areas. These animals are less likely to be affected and would require less treatment.

FURTHER INFORMATION

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FURTHER READING


N.J. Campbell (1977) Identifying liver fluke snails, Agricultural Gazette of NSW, Vol 88, No 4


Boray, J.C., Fraser, G.C., Williams J.D. and Wilson J.M. (1985) The occurrence of the snail Lymnaea columella on grazing areas in New South Wales and studies on its susceptibility to Fasciola hepatica, Aust Vet J 62: (1) 4–6


**RELATED AGFACTS**

Agfact A3.9.30 Black disease
Agfact A0.9.26 Stomach fluke in ruminants
Agnote DAI32 Liver fluke in dairy cattle.

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