Final report

PDS: Optimising Liver Fluke Management in Cattle

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Abstract

Liver fluke infection remains a widespread challenge for cattle enterprises in the high-rainfall regions of south-eastern Australia. This project aimed to optimise producers' management of liver fluke through investigating the prevalence of liver fluke, evaluating drench resistance, and determining the impact of drench timing on the growth of young cattle. Faecal egg counts, fluke egg count reduction trials and treatment comparison trials were conducted across beef properties in northeast Victoria and southeast New South Wales. Liver fluke was commonly detected, although several farms with suitable environments showed no infection, highlighting the need for evidence-based monitoring rather than routine drenching. Resistance to triclabendazole was confirmed on all seven core producer farms; however, no measurable production loss from resistance was identified, likely due to low burdens, compromised but sufficient efficacy, or short monitoring periods. Pre-winter drench timing affected winter growth rates, with poorly timed treatments reducing growth of weaners by 8–15%. Economic analysis showed no direct cost from resistance but demonstrated substantial impacts from incorrect drench timing, influencing gross margins and production costs. Extension activities improved producer knowledge, skills, and confidence, leading to practice change. The project underscores the importance of strategic drenching, routine monitoring, and further research into productivity impacts and improved diagnostic protocols.

Executive summary

Background

Liver fluke (*Fasciola hepatica*) infection is widespread in cattle and sheep across high rainfall areas (>600 mm per annum) of south-eastern Australia and other irrigated areas. Current heavy reliance on triclabendazole, an anthelmintic (drench) used to control liver fluke in cattle and sheep, is of concern due to known development of resistance. Additionally, there is a lack of knowledge about the impact of poor drenching decisions, such as suboptimal timing and or inappropriate drench selection, on weaner cattle growth rates.

The intended direct benefit of this PDS to producers and their businesses was to increase gross margin ($/ha) through more effective prevention of production losses due to liver fluke infections. An intended indirect benefit to processors and the red meat industry was an increased slaughter liveweight spread over the same processing cost, along with reduced loss in offal value.

Objectives

1. To determine if liver fluke was prevalent on beef properties in northeast Victoria and southeast NSW.

Liver fluke was prevalent on beef enterprises in northeast Victoria and southeast NSW. However, there were farms where fluke was not prevalent despite fluke-associated environmental conditions, highlighting the need for producers to monitor for fluke rather than routinely drench.

2. To determine the presence of drench resistance in liver fluke on cattle properties in northeast Victoria and southeast New South Wales and if there is an impact on growth rates in young cattle.

Drench resistance was detected on all seven core producer farms. The impact of drench resistance on growth rates could not be determined from this project and further research may be warranted.

3. To compare different pre-winter drenching times to producers' normal protocol and determine if different times have an impact on growth rates in young cattle.

Growth rates were impacted over the winter period depending on the timing of the pre-winter drench. Drenching too early or too late resulted in an 8.3 to 15.1% reduction in growth. On two of the three farms, the farmer's normal protocol resulted in the best growth rates.

Methodology

- Faecal fluke egg count tests on cattle <15 months of age to determine the prevalence of liver fluke.
- Fluke egg count reduction trials to determine the presence and production impact of drench resistance on weaner cattle.
- A pre-winter treatment comparison trial to determine the production impact of the timing of the pre-winter drench on weaner cattle.

Results/key findings

The key findings from the **demonstration sites** included:

- Liver fluke was prevalent on beef farms in northeast Victoria and southeast New South Wales as expected, however on some properties, which had an ideal environment for liver fluke, infection could not be detected through faecal monitoring for fluke eggs. This highlighted the importance of monitoring for liver fluke, rather than just drenching cattle because liver fluke is assumed to be on the property. Properties with low fluke egg counts who traditionally drenched for fluke may not need to drench every year and could use monitoring to inform this decision.
- Drench resistance to a commonly used drench, triclabendazole, was found on all seven core producers properties involved in the PDS. However, no production impacts could be identified because of drench resistance on these properties. This may reflect:
    - Low fluke burdens
    - Triclabendazole retaining sufficient efficacy to prevent production impacts despite the detected presence of resistance
    - The short time of monitoring being insufficient to show the effects of drench resistance
- There was potentially a 9 to 11 kg disadvantage over the winter/early spring period in weaners that did not receive a pre-winter drench, compared to weaners that did on farms with higher fluke egg counts.
- The timing of the pre-winter drench to strategically control liver fluke in cattle is important to ensure optimal growth rates in weaners over the winter/early spring period, with impacts on growth rates from 6.8 to 13 kg over this period.
- Challenges identified in this project included:
    - Not enough farms identified with fluke or high enough fluke egg counts included.
    - The limitations of using fluke egg counts to inform timing of pre-winter drenches when, given this only monitors adult fluke infection in cattle and not the presence of recently acquired immature fluke.

The key findings

from the **economic analysis** include the following:

- There was no economic impact observed due to drench resistance, despite all seven core producer properties having drench resistance present. Reason for this is outline above. The drench resistance trial did demonstrate that there were a reduced gross margin and increased cost of production associated with leaving animals undrenched over the winter/early spring period.
- The timing of the pre-winter drench had an impact on the gross margin ($10/DSE) and cost of production ($0.25/kg) due to differences in kilograms of beef produced per hectare (32 kg/ha), with the standard practice of one of the core producer properties determined to be drenching at the most optimal time, while one treating too early resulting in reduced growth rates over the six months following drenching.

The **extension and communication activities** that occurred throughout the duration of this PDS included:

- Workshops/seminars
- Written communication through Mackinnon Project newsletter
- Verbal communication through attendance to better beef groups

- Written communication in Agriculture Victoria's email list, Newsflash – Beef and Sheep Networks
- Case studies and producer factsheets featuring results of demonstration sites of core group members for MLA Feedback magazine

The **monitoring and evaluation** outcomes because of the PDS:

- Despite limited post project survey responses and only two of four focus groups being held at the end of the project, there were benefits from the project observed through knowledge, skills and confidence, and practice change observed in both the core and observer producers.
- There was an increase in knowledge in 85% of core producers and 52% of the observer producers in the four key areas assessed.
- The skills of the core producers in relation to when they drench, what product they use and if they monitor for liver fluke in their cattle increased because of the outcomes of the PDS.
- The confidence of core producers increased from 5.8 to 7.6 out of 10 with 80% of producers indicating they felt more confident managing liver fluke, and the confidence of observer producers increased from 4.9 to 7.6 with 100% indicating that they felt more confident.

Benefits to industry

- Improved monitoring for fluke infections through fluke egg counts or copro-antigen ELISA is a tool that more producers in the red meat industry need to adopt to enable informed decisions around the timing of a drench and if a drench is needed or not, rather than routine drenching.
- Confirmation of resistance on producer's farms, despite no demonstrated production impacts, is still important to enable producers to make informed decisions about which drench product to use, prolonging the effectiveness of an important drench to the red meat industry.
- Optimising the time of the pre-winter drench will improve the kilograms of beef produced per hectare.
- Liver fluke is having an impact on production if left untreated and could reduce overall profitability of red meat enterprises.

Future research and recommendations

Based on the results of this project, there were three areas for future research. These were:

- What is the impact of drench resistance having on productivity?
- What impact is fluke having on productivity, especially on farms which have low fluke egg counts?
- Improved monitoring protocols to inform drenching decision.

PDS key data summary table

Project Aim:
To optimise the management of liver fluke on cattle farms in northeast Victoria and southeast NSW

	Comments		Unit
Production efficiency benefit (impact) Animal production efficiency - kg LWT/ha	*Correct time of pre-winter drench increase kg beef/ha by:*	32	Kg LWT/ha
Number of core participants engaged in project		7	
Number of observer participants engaged in project	Known observers at start	48	
Event participation		147 Producers 28 Service providers	
Core group no. ha		11,310	Hectares
Observer group no. ha		21,690	Hectares
Core group no. cattle		9,500	hd cattle
Observer group no. cattle		17,000	hd cattle
% change in knowledge, skill & confidence – core	*Knowledge*	85%	Improved
	Confidence	80%	Felt more confident
% change in knowledge, skill & confidence – observer	*Knowledge*	52%	Improved
	Confidence	100%	Felt more confident
% practice change adoption – core	*Change drench to more effective product*	85%	
	Monitor for fluke	71%	
% practice change adoption – observers	*Monitor for fluke*	25%	
Key impact data			
Gross Margin / Ha	**$184/ha**		
Cost of production ($ / kg red meat)	**$0.25/kg red meat**		

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1 Background

Liver fluke infection is widespread in cattle and sheep across high rainfall areas (>600 mm) of south-eastern Australia and other irrigated areas. Due to the lifecycle of liver fluke and its reliance on a snail to complete the lifecycle, eradication is impossible. Therefore, control and prevention of disease through grazing management and strategic anthelmintic (drench) use are important. However, the reliance on the anthelmintic triclabendazole, and the increasing resistance to this drench is of concern.

Across areas of Australia where fluke is endemic, including most of Victoria and southeastern New South Wales (NSW), up to 40 million sheep and 6 million cattle graze. A recent study using faecal egg counts and copro-antigen ELISA showed that the individual animal prevalence of liver fluke in dairy cattle in six different irrigation areas across Victoria (one in the Upper Murray region) was 39%, with 46% of the herds which took part in the study likely to be experiencing production losses associated with liver fluke (Kelley et al. 2020). In the Upper Murray region, individual dairy cow prevalence was 64%. Nine out of the ten farms from the Upper Murray included in the study had a within-herd prevalence > 25% and four out of 10 farms had a within-herd prevalence of > 90%. This indicated that liver fluke is prevalent in the Upper Murray, but the question remains as to its prevalence in beef cattle because they are managed differently and often graze different country.

Production losses commonly associated with liver fluke include mortality, weight loss, reduced wool growth in sheep and reduced reproductive performance. Additionally, loss of meat and offal value due to animal health and disease costs the industry $12 to 49 million annually. In 2022, Shephard and others estimated that the cost of liver fluke to the Australian sheep industry was about $38.5 million annually (Shepard *et al* 2022). There have been no recent documented costs to the Australian beef industry, however infection is associated with lower growth rates and feed conversion ratios in fattening cattle. This can have an impact on slaughter weight as well as replacement heifers' critical mating weight. Work in the 1970s demonstrated that young stock infected experimentally with liver fluke had an 8 to 27% reduction in growth rate (Hope Cawdrey et al.1977).

Resistance to triclabendazole (TBZ) has become a worldwide problem as this drench product has been used to control liver fluke since the 1980s. Australia is no exception, with resistance detected in Victoria around the mid-1990s. Many farmers are still relying heavily on this drench placing further pressure on this already failing anthelmintic. Data collected from dairy farms between 2014 and 2016 indicated the presence of resistance to TBZ in Victoria and indicated that it may have been contributing to the high prevalence of fluke in some properties, thus impacting the overall productivity (Kelley et al 2016).

Recommendations for strategic liver fluke control in beef cattle is based off work that Joseph Boray did on the epidemiology of liver fluke. The basis for the guidelines is to reduce the number of fluke in the host and the number of fluke eggs on pasture (Joseph Boray 2017). However, the exact timing of these drenches depends on mostly climatic conditions and the weather, with drenches generally recommended in spring, August/September (to kill adult fluke), and pre-winter, April/May (to kill both immature and adult fluke), and in areas where fluke is prevalent, to give an additional drench to young stock in February. Through discussion with producers, there was a general trend for producers to control liver fluke by giving a drench for liver fluke at weaning in February or March and a second drench in August/September, or to give a drench 'in the months starting with A', April and August or after the first and last frost.

The project sought to answer three questions where it was deemed that there were industry gaps. These were:

1. How prevalent is liver fluke in beef cattle in northeast Victoria and southeast NSW?
2. Is triclabendazole resistance present on beef farms and is it having an impact on productivity?
3. Are producers routinely drenching rather than thinking about their environment and giving the pre-winter drench too early to their beef cattle and is this having an impact on productivity.

The intended benefit of this PDS to producers and their business was to increase gross margin ($/ha) through more effective prevention of losses due to liver fluke infections. This improvement would come from an increase in the kg beef/ha and reduced animal health costs through more strategic use of drenches. A benefit to processors would be an increase in slaughter liveweight spread over the same processing cost, and to the industry in the longer-term, the reduced loss of offal value, estimated to cost the beef industry $12 to 49 million annually.

2 Objectives

By September 2025, in northeast Victoria and southeast New South Wales:

1. *Estimate the prevalence of liver fluke in beef cattle by conducting fluke egg counts on faeces collected from cattle on three to five core and 30 observer producer farms*

Objective 1 was partially achieved, with fluke egg counts conducted on seven core producer farms and 18 observer producer farms.

2. *Determine the prevalence of liver fluke drench resistance to triclabendazole by fluke faecal egg counts on core producer properties and/or on observer producer properties where fluke has been identified through the prevalence survey*

Objective 2 was achieved on seven core producer farms. Not enough farms with cattle with high enough fluke egg counts could be identified through the prevalence survey to set up liver fluke drench resistance trials on eight farms.

3. *Using focus groups with core and observer producers, record their current protocol for controlling liver fluke in cattle, including use of drench, monitoring and environmental control (e.g. fencing off 'flukey' areas)*

Objective 3 was achieved on 23 farms at the start of the PDS

4. *Set up three different treatment/monitoring protocols for the control of liver fluke in cattle on three to five core farms with known liver fluke, and demonstrate the effects on:*
    a. *Weight gain in young stock - show any increase in growth rate in the 6-month period following treatment*
    b. *Fluke faecal egg counts (used to monitor infection), and*
    c. *Livestock Data Link for abattoir feedback (used to monitor infection).*

Objective 4 was achieved on three core producer farms. Weight gain and fluke egg counts were collected over two years in a separate cohort of weaners. Livestock Data Link information was not available because the cattle involved in the demonstration were not sent directly for processing. They were either heifers and retained on farm or were steers sent to feedlots.

5. *100% of core producers and 50% of observer producers will have increased their knowledge and confidence in managing liver fluke*

Object 5 was partially achieved with 85% of core producers and 52% of observer producers increasing their knowledge, and 80% of core producers and 100% of observer producers are more confident in managing liver fluke on their properties.

6. *Seventy-five percent of core producers and 50 percent of the observer producers will intend to adopt/or change their current management with revised treatment, monitoring and control protocols in their area*

Object 6 was achieved with 100% of the core produces intending to or have already made a change to their current management with a revised treatment and control protocol, following confirmation of triclabendazole resistance on their farm. 80% of the observer producers indicated in the end of PDS survey that they were either possible, likely or very likely to make changes to their management of liver fluke at the end of the PDS.

7. *Conduct a workshop with the core and observer producers to discuss the results of the prevalence survey and drench resistance results.*

Objective 7 was achieved with five workshop/seminars presented to core and observer producers to discuss the results from the PDS over the duration of the PDS.

8. *Conduct an end of PDS field day to showcase the treatment, monitoring and control protocol demonstration results to 50 producers in north-east Victoria and south-east NSW.*

Objective 8 was partially achieved with an end of project seminar held in Mudgegonga with 40 producers from north-east Victoria/south-east NSW in attendance.

3 Demonstration Site Design

3.1 Methodology

The project was comprised of three components. The first component was a small prevalence survey, the second component was the fluke egg count reduction trial, and the final component was the treatment comparison trial.

A group of 55 producers, running a total of approximately 26,500 cattle across 33,000 ha of land in northeast Victoria and southeast NSW were involved in the Producer Demonstration Site (PDS) project which ran from March 2022 to December 2025. Eighteen of these producers were involved in the prevalence survey in 2022, four were involved in the fluke egg count reduction trials in 2023 and three were involved in the treatment comparison trials which ran over 2023 and 2024. The remainder of the producers were not directly involved but received updates through attending better beef group sessions or information days organised as part of the PDS. Refer to Table 1 for a summary of the three components of the PDS.

Table 1: Summary table of the three components of the PDS, the number of participating farms and the start and finish of the data collection period

		Number of farms	Duration	
			Start	Finish
Prevalence survey		20	Jun-22	Nov-22
Fluke egg count reduction trial		4	May-23	Aug-23
Treatment comparison trial	**Year 2**	3	Apr-23	Nov-23
	Year 3	3	Apr-24	Oct-24

3.1.1 Prevalence survey

Producers involved in the prevalence survey were identified at the field day which was held at the start of the PDS in May 2022. Sampling packs with instructions were handed out to interested producers (Appendix 1). Twenty producers submitted samples for processing with results communicated back to producers. In addition, the fluke egg count results from the fluke egg count reduction trial and the treatment comparison trial were included for 2023 and 2024.

To be included in the prevalence survey, the cattle sampled needed to be between the age of 8 to 15 months and not received a drench for fluke in the three months prior to sampling.

Faecal collection for fluke egg counts was conducted by the farmers. They were instructed to collect 10 x fresh faeces in the paddock and send the samples to The University of Melbourne in Werribee for fluke egg counts via the flotation method.

A very basic analysis of prevalence over the duration of sampling (June to November 2022) was undertaken for total prevalence and within flock prevalence. There were not enough herds or number of cattle sampled to be able to calculate a true prevalence for liver fluke in northeast Victoria or southeast NSW.

3.1.2 Fluke egg count reduction trial

Following the prevalence survey, producers with the highest fluke egg counts were contacted for recruitment for the fluke egg count reduction trial. Four of the 20 producers who submitted samples had fluke egg counts greater than 10 eggs per grams. These producers were recruited into the fluke egg count reduction trial. Farm location and details are in Table 2 and the number of Dry Sheep Equivalent (DSE) and total number of stock are in Table 3.

Table 2: The location, rainfall, size of farm, soil type, pasture species and pasture growing season for each of the beef-producing farms in northeast Victoria and southeast New South Wales included in the fluke egg count reduction trial.

Farm	Location	Annual rainfall (mm)	Effective farm size (ha)	Soil type	Predominant pasture types	Typical growing season
A	Tumbarumba, New South Wales	980	1440	Granite based sandy clay loam	Phalaris	April-December
B	Indi, New South Wales	942	600	Basalt loams and alluvial/loams	Ryegrass and clovers	April-November
C	Tintaldra, Victoria	800	520	Clay loam, granite and allevial	Phalaris, ryegrass and clover	April-November
D	Tawonga, Victoria	980	2600	Sandy loam/Alluvial	Ryegrass and clovers	April-December

Table 3: The total Dry Sheep Equivalent (DSE), number of stock and breed for each of the beef-producing farms in northeast Victoria and southeast New South Wales included in the fluke egg count reduction trial.

Farm	Total DSE	Number of		Total number of sheep	Predominant breed
		Cattle (all classes)	Adult females		
A	16600	1850	900	0	Angus
B	5,520	460	200	0	Simmental
C	9,570	700	340	10	Angus
D	13,200	1100	500	0	Hereford

On each farm, approximately 60 weaners (<12 months), were pre-screened for the presence of fluke eggs (Visit 1). Seven days following the pre-screen, 45 weaners with the highest fluke egg counts where randomly divided into three groups, control (no treatment), treatment with triclabendazole or treatment with nitroxinil/clorsulon (Visit 2) and treated accordingly. After 26 days, faecal samples were collected from these weaners and submitted for fluke egg counts (Visit 3). Refer to Table 4 for a summary of activities that occurred at each visit and Table 5 for the dates each visit occurred. Reductions were calculated by comparing the individual fluke egg count at Visit 2 to the count at Visit 3.

Table 4: Activities that occurred at each visit in the fluke egg count reduction trial

Visit 1	Visit 2	Visit 3
Day -7	Day 0	Day ~26
Sampled and weighed x60	Drenched and weighed x45	Sampled and weighed x45

Table 5: Date of each visit to each farm for the fluke egg count reduction trial

Farm	Visit number		
	1	2	3
A	17-Jul-23	24-Jul-22	18-Aug-22
B	-	12-Jul-22	07-Aug-22
C	01-May-22	11-May-22	05-Jun-22
D	30-May-22	15-Jun-22	11-Jul-22

Also included in the fluke egg reduction trial were results from the treatment comparison trial which included the pre and post fluke egg counts following treatment with triclabendazole (Year 2 – 2023) and nitroxinil/clorsulon (Year 3 – 2024).

In addition to faecal samples being collected for fluke egg counts, all weaners were weighed at either Visit 1 or 2 and then again at Visit 3. A comparison of weight gain or loss was made between each of the treatment groups.

3.1.3 Treatment comparison trial

3.1.3.1 Farms

Three producers reached out with an interest to further understand the management of liver fluke on their property. The enterprises these producers managed were recruited as sites to set up the

treatment comparison trial on. Farm location and details are in Table 6 and the number of DSE and total number of stock are in Table 7.

Table 6: The location, rainfall, size of farm, soil type, pasture species and pasture growing season for each of the three beef-producing farms in northeast Victoria and southeast New South Wales included in the treatment comparison trial.

Farm	Location	Annual rainfall (mm)	Effective farm size (ha)	Soil type	Predominant pasture types	Typical growing season
E	Tumbarumba, New South Wales	980	4000	Mainly granite, with some basalt, shale and alluvial	Sub clover and Phalaris base with naturalised ryegrass and annuals	April-December
F	Koetong, Victoria	1100	700	Granite	Sub clover, Phalaris and Poa annua	April-December
G	Running Creek, Victoria	1050	237	Sandy loam/Alluvial	Ryegrass and sub clover	April-December

Table 7: The total Dry Sheep Equivalent (DSE), number of stock and breed for each of the three beef-producing farms in northeast Victoria and southeast New South Wales included in the treatment comparison trial.

Farm	Total DSE	Number of		Total number of sheep	Predominant breed
		Cattle (all classes)	Adult females		
E	50,000	3700	1600	36,000	Angus
F	13,000	1400	700	0	Angus
G	3,850	275	150	0	Hereford

3.1.3.2 Trial design

Data from the treatment comparison trial was collected over a two-year period (Year 2 and Year 3). The same trial design was set up each year on a different cohort of weaner cattle. In both years, 60 weaners (6 months of age), were randomly allocated into three groups and following treatments were continued to be managed together. Outlined in Table 8 are the details of the treatment each group received. The groups were:

Group 1: Producer's own management protocol for liver fluke

Group 2: May/ June treatment

Group 3: July/August treatment

In Year 2 of the trial, resistance was identified to triclabendazole. Therefore, after discussion with the producers, it was decided to switch to nitroxinil/clorsulon in Year 3 as this drench is known to be 100% effective against liver fluke.

Table 8: The details of treatment times and drench used for each group, on each farm in Year 2 and 3

Group	Farm	Year 2 (2023)		Year 3 (2024)	
		Drench used	When given	Drench used	When given
1	E	Nitroxynil/clorsulon	25-May	No treatment	
	F	Oral Triclabendazole	10-May	Nitroxynil/clorsulon	17-Apr
	G	Pour on Triclabendazole	29-May	Nitroxynil/clorsulon	6-May
2	E	Oral Triclabendazole	25-May	Nitroxynil/clorsulon	28-May
	F	Oral Triclabendazole	1-Jun	Nitroxynil/clorsulon	26-May
	G	Oral Triclabendazole	29-May	Nitroxynil/clorsulon	29-May
3	E	Oral Triclabendazole	3-Aug	Nitroxynil/clorsulon	15-Jul
	F			Nitroxynil/clorsulon	1-Jul
	G	Oral Triclabendazole	31-Jul	Nitroxynil/clorsulon	19-Jul

In Year 2 and 3 of the trial, up to six visits occurred on all three farms between April and November. Table 9 summarises the activities that occurred at each visit. These included weighing weaners, collecting faecal samples (sampled) for fluke egg counts and drenching at specific times. Table 10 and Table 11 show the timing that each visit occurred on each farm.

In Year 2 on Farm F, the trial was terminated after Visit 3 (Table 10) because many the weaners were failing to gain weight and visually looked to be suffering. It was also found on this farm that triclabendazole was not effective. The weaners were all drenched with nitroxynil/clorsulon after Visit 3 and no more data was collect on Farm F in Year 2.

In Year 3 on Farm F, all groups were treated with a drench that contained closantel four weeks prior to Visit 6 despite this not being part of the trial design.

Table 9: Activities that occurred at each visit in the treatment comparison trial

Visit 1	Visit 2	Visit 3	Visit 4	Visit 5	Visit 6
Weighed, allocated	**Drenched** and sampled Group 2, Weighed all	Sampled Group 2, weighed all	**Drenched** and sampled Group 3, weighed all	Sampled Group 3, weighed all	Sampled and weighed all

Table 10: Date of each visit to each farm in Year 2 (2023) of the treatment comparison trial

Farm	Visit number					
	1	2	3	4	5	6
E	20-Apr-23	25-May-23	22-Jun-23	3-Aug-23	31-Aug-23	7-Nov-23
F*	17-Apr-23	**01-Jun-23**	29-Jun-23			
G†	-	29-May-23	-	31-Jul-23	**28-Aug-23**	13-Nov-23

*****Severe drench resistance was detected on Farm F after the post drench egg count at Visit 3, and the animals were suffering, so it was decided on humane grounds to terminate the trial on this farm for Year 2.

† Visit 1 and 2 were combined at Visit 2. Producers were away for Visit 3 so the post drench egg count was not conducted.

Table 11: Date of each visit to each farm in Year 3 (2024) of the treatment comparison trial

Farm	Visit number					
	1	2	3	4	5	6
E	17-May-24	28-May-24	18-Jun-24	15-July-24	06-Aug-24	13-Oct-24
F	17-Apr-24	26-May-24	01-Jul-23*		29-Jul-24	01-Oct-24†
G	06-May-24	29-May-24	19-Jun-24	19-Jul-24	09-Aug-24	10-Oct-24

*Visit 3 occurred more than 21 days following Visit 2 due to the farmer not being available, therefore Visit 3 and 4 were combined on this farm

† Drenched with closantel four weeks prior, despite this not being part of the trial design.

3.2 Economic analysis

In order to assess productivity measures such as kilogram of red meat produced per hectare and per DSE, and profitability measures such as cost of production, data from the 2023/24 Agriculture Victoria's Livestock Farm Monitor Project (LFMP) was used in conjunction with liveweight data and cost of drench data collected from this project.

To calculate cost of production and productivity measures, the enterprises were assumed to be trading enterprises because the impact of fluke was only assessed on weaners and not adult stock, eg. breeding cows.

The overhead costs used were an average of the northern beef trade enterprises taken from LFMP, whereas the variable costs used were taken from the average for northern beef (all enterprises) because the variable costs for trade enterprises were deemed to be too high and not a true reflection of variable costs.

Long-term livestock prices were used for the different weight categories.

3.3 Extension and communication

To extend the results of this project to the core/observer producers and the wider community in northeast Victoria and southeast NSW, the following activities were included in the communication plan.

- Workshop/seminars
- Written communication through Mackinnon Project newsletter
- Verbal communication through attendance to better beef groups
- Written communication in Agriculture Victoria's email list, Newsflash – Beef and Sheep Networks
- Case studies and producer factsheets featuring results of demonstration sites of core group members for MLA Feedback magazine

Refer to Appendix 2 for an outline of the communication plan.

3.4 Monitoring and evaluation

The producers who had a fluke egg count reduction trial or treatment comparison trial set up on their farm were classified as 'core' producers in the project. All other producers who showed interested or filled in a pre-project survey were classified as 'observer' producers.

A pre-project survey was completed by seven core and 16 observer producers at a group meeting/focus group at the beginning of the project to assess their knowledge on the impact of liver fluke on their enterprise, and the liver fluke lifecycle. The producers were also asked about how they currently manage liver fluke and how satisfied they are with their management of liver fluke on their farm.

The post project survey was completed by five core and 12 observer producers at a group meeting/focus group at the end of the project or via surveys emailed to producers. The same questions were asked to determine knowledge, skills and confidence, practice change/adoption in relation to liver fluke management following the project.

Refer to Appendix 3 for details of the metrics measured. Enterprise indicators collected included hectares managed and approximate livestock numbers of core and observer producers. Productivity metrics collected included growth rates and pregnancy rates on some of the core producer farms. Profitability metric included an analysis of the cost of production ($/kg) and gross margin ($/ha and $/DSE).

4 Results

4.1 Demonstration site results

4.1.1 Prevalence survey

Twelve out of the 20 samples that producers submitted (60%) had evidence of fluke infestation in their cattle. Table 12 shows the average egg counts across all 20 farms sampled in 2022, the age and sex of the animals sampled, and the location of the farms which samples were submitted from.

The average fluke egg count across these farms was 6.5 eggs per gram (epg) of faeces, with the highest average for one farm being 60.5 epg. This farm had an individual count as high as 345 epg, with all ten animals sampled on this farm having evidence of a fluke infestation. There were three out of the 20 farms sampled where all ten animals sampled had a positive egg count. On the farms where fluke was present, an average of at least half (5 out of 10) of the animals tested had evidence of a fluke infestation.

Table 12: The location of samples collected, age and sex of cattle sampled, the average fluke count and number of samples out of 10 with eggs present

Location	Average annual rainfall (closest weather station)	Age	Sex	Average Egg Count (epg)	Number of samples with eggs/10
Tumbarumba, NSW	978.7	11 to 12 months	Mixed	1.2	2
Koetong, VIC	1223.1	12 months	Mixed	31.4	10
Towong, VIC	815.5	12 months	Mixed	16	9
Cravensville, VIC	1223.1	12 months	Mixed	2.6	2
Indi, NSW	942.1	10 months	Mixed	60.5	10
Whorouly South, VIC	1033.2	22 months	Heifers	0	0
Mudgegonga, VIC	1033.2	10 months	Steers	0.7	3
Mudgegonga, VIC	1033.2	9 to 10 months	Steers	0	0
Chiltern, VIC	620.7	10 to 11 months	Steers	0	0
Talgarno, VIC	699	15 months	Heifer	0	0
Chiltern, VIC	620.7	10 months	Heifers	0	0
Bonegilla, VIC	699	14 months	Heifers	0.8	1
Barnawartha, VIC	620.7	12 to 17 months	Mixed	0	0
Charleroi, VIC	832.4	10 to 12 months	Steers	0.6	3
Tawonga, VIC	959.6	12 months	Heifers	0.2	1
Tawonga, VIC	959.6	10 to 11 months	Steers	2	6
Kancoona, VIC	959.6	13 months	Heifers	13.2	10
Byawatha, VIC	615.1	8 to 10 months	Mixed	0	0
Welaragang, NSW	768.9	12 to 13 months	Steers	0.4	1
Wingan, VIC	615.1	12 to 24 months	Steers	0	0

There was a total of 200 samples analysed from the 20 farms between June and November, and of these samples, there were 58 positives. If a very basic prevalence is calculated, this equals 29%. The samples collected from farms in regions with the lowest rainfall, Chiltern, Barnawartha, Byawata and Wingan (615 to 620 mm) were all negative for liver fluke eggs. If these farms and the farms that samples were collected from cattle older than 15 months, were removed to the simple prevalence calculation, the prevalence of liver fluke increased to 41% across the high rainfall areas (699 to 1223 mm) of northeast Victoria and southeast NSW.

Some of the farms in high rainfall areas, such as those in Tumbarumba, Whorouly South and Mudgegonga, had low fluke egg counts despite the environmental and weather conditions being conducive to fluke survival.

On Farms E to G, which were demonstration sites for the treatment comparison trial, the prevalence of liver fluke on the farms was calculated for Year 2 (2023) and Year 3 (2024). Table 13 shows the change in prevalence from Year 2 to Year 3 and the number of negative and positive samples for each year. For this project, it was deemed that Farm E had a low fluke infection, Farm F a high fluke infection and Farm G a moderate infection. The prevalence of fluke on all farms changed from Year 2

to 3, a reflection of variations in fluke pick-up due to varying environmental and weather conditions between years.

Table 13: The number of positive and negative samples for fluke eggs and the prevalence of fluke on Farms E to G in Year 2 (2023) and Year 3 (2024) of the treatment comparison trial

Farm	Positive		Negative		Prevalence (%)	
	Year 2	Year 3	Year 2	Year 3	Year 2	Year 3
E	4	7	16	13	20%	35%
F	21	16	0	4	100%	80%
G	17	11	2	8	89%	58%

4.1.2 Fluke egg count reduction trial

The results from the fluke egg count reduction trial (FlECRT) are summarized in Table 14 and includes results from the reduction trials conducted in the treatment comparison trials (Farms E to G). There was resistance to triclabendazole present on all farms, with the percent reduction ranging from 0 to 86%. The confidence intervals around these reductions are very wide due to the low egg counts, however it still indicates that there is resistance to triclabendazole present on all farms in the trial.

There was minimal resistance found to nitroxynil/clorsulon on all farms. On Farm A, the reduction was 93% which is a result of one animal's fluke egg count reduction being 0% (4 epg found on both the pre and post drench sample). The remaining 14 animal's fluke egg count reductions were 100%. Additionally, on Farm B, one of the animals had an egg count of 372 epg at the pre drench sample and its count was reduced to 56 epg at the post drench count, resulting in an 85% reduction in this animal. The remainder of the animals on Farm B had a reduction of 100%.

Table 14: Results from the fluke egg count reduction trials conducted on Farms A to G.

Farm	Average eggs per gram of control group post drench	% Reduction – Oral triclabendazole	% Reduction – Nitroxynil/clorsulon
A	14	67%	93%*
B	43	50%	99%
C	11	82%	100%
D	15	0%	100%
E	2.5	81%	100%
F	23	0%	100%
G	6	0%	100%

*Only 1 egg found at both pre and post drench

There was no significant weight difference between any of the groups (Table 15), **although the general trend (although very small difference) indicated that animals treated with nitroxynil/clorsulon had the greatest weight gain when averaged across the five farms, 18.1, 17.8 and 16.2 kg for nitroxynil/clorsulon, triclabendazole and control groups, respectively.** The lack of impact on production due to drench resistance in triclabendazole may be due to the unreliability of fluke egg counts, that triclabendazole reduced the fluke burden enough that there was no impact on production or there was not enough time between visits to assess the impact resistance was having on growth.

If the average daily weight gain for each group, 0.68, 0.69 and 0.63 kg for nitroxynil/clorsulon, triclabendazole and the control group, respectively, was used to calculate the total weight gain over 6 months, the weight gain at the end would be 122, 124 and 113 kg for nitroxynil/clorsulon, triclabendazole and the control group, respectively. **Although not significant and the unknown effect of the ongoing fluke burden over winter when cattle are under nutritional stress (cattle in the drench trial were not weighed at the end of six months), potentially untreated weaners are showing a production impact compared to treated weaners.**

Table 15: The average total weight gain and average daily gain between visit 2 (time of treatment) and visit 3 (~25 days post treatment)

Farm	Group	Average weight change	Average daily gain
A	Nitroxynil/clorsulon	21.8	0.81
	Triclabendazole	18.7	0.75
	Control	19.8	0.79
B	Nitroxynil/clorsulon	13.5	0.50
	Triclabendazole	13.1	0.52
	Control	11.6	0.45
C	Nitroxynil/clorsulon	9.4	0.38
	Triclabendazole	9.9	0.39
	Control	7.9	0.31
D	Nitroxynil/clorsulon	38.3	1.47
	Triclabendazole	39.6	1.52
	Control	36.5	1.41
E*	Nitroxynil/clorsulon	7.6	0.26
	Triclabendazole	7.7	0.28
	Control	5.3	0.18

*Farm E was included in the treatment comparison trial but results from this could be used to compare weight of different treatments

4.1.3 Treatment comparison trial

4.1.3.1 Year 2

In Year 2 after Visit 3 on all three farms, it was identified that triclabendazole resistance was present. This had a significant impact on the weaners' welfare on Farm F, with the trial having to be terminated and the weaners drenched with an effective product, nitroxynil/clorsulon.

The trial was continued on both Farm E and G, and there was no significant difference in weight gain from the start of the project to the end (Table 16). However, on Farm G, where a pour on triclabendazole was used in Group 1 (producer's normal management protocol) and an oral triclabendazole in Group 2, both at Visit 2 (end of May), Group 2 had a 9 kg advantage in weight gain compared to Group 1 by the end of the data collection period. Group 3 also had an 8.5 kg advantage compared to Group 1 (Group 3 received an oral triclabendazole at the end of July). It is known that the effectiveness of pour-on drench products is less reliable compared to oral products, and despite there being resistance to triclabendazole being present on this farm, it appears that the oral triclabendazole may be more effective compared to the pour-on. It is difficult to make this conclusion with the fluke egg counts because there was no collection made at Visit 3 (25 days following Visit 2).

On Farm E, the farmers normal protocol was to use nitroxynil/clorsulon. At Visit 3, 25 days following a drench with nitroxynil/clorsulon (Group 1) or triclabendazole (Group 2), there was no significant difference in weight gain. This may have been expected because triclabendazole was 82% effective on this farm (Table 14) and the fluke egg counts were low, average of 1.4 epg at treatment time. Interestingly though, Group 3 following triclabendazole treatment in early August, had a significantly greater weight gain than Group 1 (9.3 kg) at Visit 5, 25 days following treatment. The significance of this may reflect compensatory growth because there was very little difference in weight gain between the three groups for the duration of the trial, and the fluke burden on this farm was deemed low based on the fluke egg counts.

Table 16: Average weight gain from the previous visit, total gain from start to finish (total), and average fluke egg count in brackets for each group on each farm in Year 2 (2023). Blue shading is weight gain following nitroxynil/clorsulon treatment and orange shading is weight gain following triclabendazole treatment.

Farm	Group	Visit					
		2	3	4	5	6	Total
E	1	9.9	7.6	12.3	2.1[a]	98.1 (0.8)	129.3
	2	9.15 (1.4)	7.7 (0.1)	6.6	6.8	97.4 (3.0)	127.6
	3	9.7	5.3	12.1 (3.5)	11.4[b] (0.8)	93.2 (1.2)	131.2
F[†]	1	0.9					
	2	2.3 (22.1)	(34.3)				
	3	1.5					
G*	1			14.5	32.2	88.4 (4.3)	135.1
	2	(39.7)		15.4	35.5	94.5 (4)	144.1
	3			18.1 (6)	33 (6.6)	92.3 (3.7)	143.5

[a] Different superscript in a column denotes a significant difference between groups on that farm ($p < 0.05$), *No weight of Fl.EC done at visit 3, [†]Trial terminated after Visit 3, no weight collected at Visit 3

4.1.3.2 Year 3

Nitroxynil/clorsulon was used on all farms in Year 3. The producer's normal protocol also changed on each of the three farms. On Farm E, they decided not to use any drench, which was part of their normal management and dependant on season, and Farm F and G used nitroxynil/clorsulon based on Year 2's results.

The spring of 2023 was dry, followed by a very late break in 2024, which meant that the pasture available for stock on all three farms was limiting during late autumn and winter for 2024 and all farms had to supplementary feed their stock over this period. This was reflected in the results with weight loss on all three farms between visits (Table 17), with gains substantially lower than Year 2 (2023). Refer to Appendix 4 (Table 30 and Table 31) for average weights at each visit.

On Farm E, which had a low fluke egg count at Visit 1, the untreated group gained the most weight for the duration of the project, 6 to 8 kg more than the group treated in late May (Group 2) and mid-July (Group 3), respectively. There was no advantage following treatment at either late May or mid - July, even in a year when growth was poor due to a poor season. Like Year 2, egg counts were low and potentially fluke is not causing production losses on this farm every year. **Therefore, on this farm which had a low fluke burden based on fluke egg counts, the trial confirmed that routine drenching every year is not necessary, particularly in years following a very dry period. Decisions**

to drench on this farm may be subject to monitoring fluke egg counts during late autumn and consideration of the season.

On Farm F, Group 2, which was treated in late May, had a 13 and 10 kg growth advantage over a mid-April treatment and early July treatment, respectively, by the end of the monitoring period. Group 2 had a lower egg count at this point too (Table 17), despite all groups receiving a drench containing closantel four weeks prior to the end of the monitoring period. The impact of drenching too early for the pre-winter fluke drench may be more obvious (production loss and higher fluke egg counts) on Farm F due to the higher fluke burden on this farm. If they are drenching too early, there may be continued fluke pick up following the drench. **On Farm F, which had a high fluke burden, the normal protocol to drench in mid-April (or sometimes earlier at weaning), is resulting in production losses due to continued fluke pick up following treatment. It was therefore recommended on this farm to give the pre-winter drench in mid to late May.**

On Farm G, which had a moderate fluke burden in comparison to the other two farms and other egg count results analysed during the project, their normal management protocol, which is to give weaners a pre-winter treatment in early May, resulted in a 7 and 7.5 kg weight advantage compared to treating at the end of May and early July. Additionally, all group's fluke egg counts were 0 epg by the end of the monitoring period, potentially reflecting no pickup of fluke following treatment. **Therefore, on Farm G, the producers timing of the pre-winter drench (early May) suited the environment and meant there was very little if any fluke pickup following treatment.**

Table 17: Average weight gain from the previous visit, total gain from start to finish (total), and average fluke egg count in brackets for each group on each farm in Year 3 (2024). Blue shading is weight gain following nitroxynil/clorsulon treatment.

Farm	Group	Bulk egg count visit 1	Visit					Total
			2	3	4	5	6	
E	1	3	-7	-5.5	-0.4	9.2	73.9 (0.7)	71.8
	2		-4.5 (1.8)	-7.9 (0)	-1.8	7.4	71.2 (0.3)	65.8
	3		-6.5	-6.8	-1.8 (0.3)	9.0 (0.1)	69.7 (0.1)	63.8
F	1	16	15	-13.9		3.2	68.9 (5)	73.3
	2		16.7 (17.5)	-8.5 (0)		5.6	72.6 (1.6)	86.3
	3		18.3	-13.2 (12.3)		4.7 (0)	66.1 (0.9)	76.4
G	1	7	2.3	6.7	10.5	-12.9	61.4 (0)[a]	67.8
	2		1 (5.5)	10 (0)	8.9	-10.8	51.9 (0)[b]	61
	3		3.8	8.8	9.5 (2.1)	-16.1 (0)	54.9 (0)	60.4

[a] Different superscript in a column denotes a significant difference between groups on that farm ($p < 0.05$)

The percent of animals pregnant in each group on farms E and G are shown in Table 18 for Year 2. There was no data collected for Farm F in Year 2 because the trial was terminated. In Year 3, the data submitted for Farm E did not have individual animal identification so could not be used. Farm F had steers and heifers, so the pregnancy data was not collected and on Farm G, the data was not submitted.

There was no relationship between weight at the end of the trial period (joining time on both farms) and pregnancy rate in heifers on both Farm E and G in Year 2. The pregnancy rate in Group 2 on Farm E was about 20% lower than Group 1 and 3, however this was not related to a lower body

weight at joining time because it is very similar to Group 1. However, it is interesting to note that despite the heifers on Farm G being at least 70kg heavier than those on Farm E, their pregnancy rate was up to 22% lower than Farm E.

Table 18: Pregnancy percentages (weights (kg) at end of the monitoring period in brackets) for each treatment group on farms E and G in Year 2 (2023)

	Group		
	1	**2**	**3**
Farm E	94% (289.8)	75% (290.8)	95% (306.3)
Farm G	67% (374.1)	67% (373.2)	72% (378.2)

4.2 Economic analysis

In the economic analysis, the variable cost from the LFMP was used ($32/DSE), and the variable, overhead and labour costs from the LFMP were used to calculate the total cost ($83.5/DSE). The cost of the drench per animal and DSE was $1.60/animal or $0.21/DSE for triclabendazole and $5.20/animal or $0.70/DSE for nitroxynil/clorsulon. It was assumed that the variable cost from the LFMP incorporated one triclabendazole drench and was adjusted accordingly depending on what drenches were given in the project.

Livestock prices ($/kg liveweight) used are listed below for each weight category for Angus cattle. For Herefords an assumption was made that feeder steers receive a $0.30/kg discount and weaners a $0.50/kg discount.

- < 400 kg - $5.40
- > 400 kg - $5.20
- < 200 kg - $6.23
- > 200 kg - $6.09

4.2.1 Fluke egg count reduction trial

To calculate the economic impact of drench resistance (Table 19), the difference in average daily gain for each group from treatment to ~25 days post treatment (Table 15) was averaged using data from farms A to E. This was then used to determine the difference in weight gain over a six-month period following treatment. The ADG for each group was 0.68, 0.69 and 0.63 kg for nitroxynil/clorsulon, triclabendazole and the control groups, respectively. The total weight gain over six months using the ADG was 122, 124 and 113 kg for nitroxynil/clorsulon, triclabendazole and the control groups, respectively. The opening weight at drenching time was different on all farms for each group, however, to simplify calculations, 200 kg was used for each group.

Following treatment with either nitroxynil/clorsulon or triclabendazole, there was not much difference in the economic impact. However, there was a $11/DSE and $9/DSE difference in gross margin between the untreated scenario and the scenario treated with triclabendazole and nitroxynil/clorsulon, respectively, as was there a $0.12/kg and $0.08/kg difference in the cost of production, respectively. **This highlights that fluke is having an impact on production and profitability if left untreated.**

One of the limitations with this analysis is that the ADG over 25 days has been used to extrapolate the weight gain over a six-month period, which doesn't allow for the impact, if any, of drench resistance to be observed. The lack of impact on production due to drench resistance in

triclabendazole may be due to the unreliability of fluke egg counts, that triclabendazole reduced the fluke burden enough that there was no impact on production or there was not enough time between visits to assess the impact resistance was having on growth.

Table 19: Productivity and profitability measures of drenching with either Nitroxynil/clorsulon or Triclabendazole, or leaving untreated (control). Green shaded cells indicate the best productivity and profitability.

Group	kg/ha	kg/DSE	GM ($/ha)	GM ($/DSE)	COP ($/kg)
Nitroxynil/clorsulon	458	34.2	1,699	127	2.46
Triclabendazole	462	34.5	1,724	129	2.42
Control	439	32.8	1,586	118	2.54

4.2.2 Treatment comparison trial

Across both years and on each farm, there was no trend for which treatment time resulted in the best productivity and profitability (Table 20 and Table 21). However, there were a few points to highlight on some of the farms, particularly in Year 3 when nitroxynil/clorsulon was used (Table 21).

In Year 3 on Farm E at Tumbarumba in New South Wales, which had a low fluke egg count compared to the other farms in the project, leaving animals untreated had a lower cost of production (lower by $0.24 and $0.22/DSE compared to treating in May and July, respectively)) and a higher gross margin (by $11 and $9/DSE compared to treating in May or July, respectively). This was driven by more meat produced and lower costs due to no drench being used.

On Farm F at Koetong Victoria, and for reference, had a relatively high fluke egg count compared to the other farms in the project, there was a clear advantage to treating weaners in late May compared to treating when the farmer would normally in April (Table 21). The cost of production was $0.25 less than treating in April and the gross margin was $10/DSE higher. This was driven by more meat produced per hectare.

On Farm G at Running Creek in Victoria, the farmers normal treatment time, early May had the lowest cost of production and highest gross margin. This is driven by a more meat being turned off per hectare.

Table 20: Productivity and profitability measures of treating at different times from May to August compared to when the farmer would normally treat (Group 1) on Farms E and G in Year 2 (2023). Green shaded cells indicate the best in productivity and profitability.

Farm	Group	kg/ha	kg/DSE	GM ($/ha)	GM ($/DSE)	COP ($/kg)
E	**1**	297	23.8	1,704	136	3.53
	2	296	23.7	1,703	136	3.53
	3	302	24.2	1,748	140	3.46
G	**1**	487	29.5	1,739	105	2.83
	2	503	30.5	1,854	112	2.74
	3	503	30.5	1,842	112	2.74

Table 21: Productivity and profitability measures of treating at different times from May to July compared to when the farmer would normally treat (Group 1) on Farms E to G in Year 3 (2024). Green shaded cells indicate the best productivity and profitability.

Farm	Group	kg/ha	kg/dse	GM ($/ha)	GM ($/dse)	COP ($/kg)
E	1	287	22.9	1,294	104	3.63
	2	272	21.7	1,166	93	3.87
	3	273	21.8	1,183	95	3.85
F	1	432	23.3	1331	72	3.60
	2	464	25.1	1515	82	3.35
	3	439	23.7	1387	75	3.54
G	1	346	21.0	1,212	73	4.00
	2	332	20.1	1,130	69	4.17
	3	331	20.1	1,118	68	4.19

4.3 Extension and communication

Throughout the duration of the project, six field days/seminars were held, two articles were produced for the Mackinnon Project newsletter, with a third to be produced at the start of 2026, three beef groups were attended to conduct pre-project focus group discussion and surveys, two were attended to conduct post-project focus group discussion and surveys, one beef group was attended to discuss interim results, one communication was written for Agriculture Victoria's Newsflash email list, two producer case studies were produced and a producer factsheet. Refer to Table 22 for an outline of the engagement activities, the messages and a summary of the audience, number of attendees and any additional messages.

Some of the comments following our end of project seminar included:

"Thanks for the great day."

"Thanks again for the day. It was well worth the trip over to attend."

"I found the day very interesting and valuable."

"It was indeed a very useful day, one of the better things I've been to."

"I had a great day."

"Enjoyable day Leah."

"Thanks for putting on a great event, I learnt a lot and was structured very well for the day."

"It was a great day. Thanks for organising it."

"I found the meeting had some very good information."

Table 22: Engagement activities, timing, communication tactic and channel, the messages conveyed and a summary of the audience and number of attendees

Timing	Communications tactics	Communications channel	Messages	Summary
Year 1				
31st May 2022	Start of PDS field day. Refer to Flyer (Appendix 5)	Presentations presented by Leah Tyrell and John Webb Ware both of the Mackinnon Project, and Sue Briggs from CSBP	Liver fluke: Lifecycle, disease and strategic management Drenches and drench resistance Information on the PDS	40 participants attended including 5 consultants. Additional messages included making informed decisions around fertilizer application and high land prices
Year 2				
Year 2 (2023) – Feb	Written article. Refer to Appendix 6	Mackinnon newsletter, MLA channels (The Weekly; Feedback magazine; social channels)	PDS outline and an update on the results of year 1 of the PDS	First article with PDS outline was disseminated to Mackinnon Project clients in December 2022.
Year 2 (2023) – Feb	Written communication	Leah Tyrell will email an update of results to BWBL and BBN coordinators who will disseminate to their members, Mackinnon Project social channels	PDS outline and an update on the results of year 1 of the PDS	Regular contact was made with Chris Mirams, who coordinated four of the beef groups involved in the PDS. No formal email with updates was circulated however, in 2024, three additional activities were organized to disseminate results from Year 1 and 2 of the PDS
11th Dec 2023	Mackinnon seminar. Refer to Flyer (Appendix 5)	Presentations by Leah Tyrell, John Webb Ware, Ben Blomfield of the Mackinnon Project and Dennis Watson from Agriculture Victoria	Update from prevalence survey/drench resistance testing, interim results form Year 2 of the treatment comparison trial. Management of liver fluke Summary of finding from focus group surveys of	Twenty-two producers, 1 Virbac representative and a speaker from Agriculture Victoria were present at the field day at Kiewa Valley. Others from Mackinnon Project also spoke at the field day. Additional

			producers management of liver fluke.	messages included drought management, irrigation and Mackinnon Project activities.
Nov/Dec 2023	Written article. Refer to Appendix 6	Mackinnon newsletter, MLA channels (The Weekly; Feedback magazine; social channels)	An update on the results of year 2 of the PDS	Second article with PDS preliminary results was disseminated to Mackinnon Project clients in December 2023.
Year 3				
12th June 2024	Better Beef producer group	Presentation	Interim results Year 2 from drench resistance trial and treatment comparison trial. Management of liver fluke	Additional activity, not scheduled in the original communication plan. Eight producers were present at the producer group, which was held at Tawonga, Vic.
23rd October 2024	Mackinnon seminar. Refer to Flyer (Appendix 5)	Presentation. Speakers included John Webb Ware, Ben Blomfield and Daniel Brookes from Mackinnon Project and Dale Gray from Agriculture Victoria.	Interim results – Year 2 from drench resistance trial and treatment comparison trial.	Additional activity, not scheduled in the original communication plan. Twenty-five participants were present, which included 12 producers, and 13 university veterinary students and was held at Shelford, Vic. Additional messages included drought management, seasonal updates and recent Mackinnon activities.
18th November 2024	Genomics workshop for Northeast Better Beef Groups.	Presentation. Speakers include Leah Tyrell, John Webb Ware and	Management of liver fluke and interim results from Year 3 of the	Additional activity, not scheduled in the original communication

	Refer to Flyer (Appendix 5)	Ben Blomfield of the Mackinnon Project, Jake Bourne from Zoetis, and Dane Skinner from Big Springs	treatment comparison trial	plan. About 35 producers, 3 Zoetis representatives and 1 agricultural consultant were present at this workshop, which was held in Albury, NSW. Additional messages included breeding and seasonal management decisions
Year 4				
3rd March 2025	Workshop	Presentation	Summary of project results	Additional activity. In attendance researchers involved in the study and control of fasciolosis, a parasitic disease of growing concern in Australia
27th August 2025	End of PDS field day. Refer to Flyer (Appendix 5)	Presentations and hand outs Presentations via Leah Tyrel, Ben Blomfield, John Webb Ware and Ben Ashton all Mackinnon Project consultants.	Summary of finding from the comparison trials and recommendation for optimal management of liver fluke in cattle	Mackinnon Project Seminar – Smart Recovery, Smart Decisions – Pasture, Parasites and Profit, held in Mudgegonga. There were 40 producers attend and 5 consultants. Presentations were sent out to producers. Additional messages included drought management, leasing and drench resistance in sheep worms
Year 4 (2025) – Jul	Written article	Mackinnon newsletter, MLA channels (The Weekly; Feedback magazine; social channels)	Update on the results of year 2 and 3 of the PDS	No article has been published for the Mackinnon Project newsletter due to a temporary pause in production. It is planned to resume

				at the start of 2026 in which an article will be produced for.
Year 4 (2025) – Jul	Written communication	Leah Tyrell will email an update of results to BWBL and BBN coordinators who will disseminate to their members, Mackinnon Project social channels	Update on the results of year 2 and 3 the PDS	Attended Kiewa Valley, Upper Murray Mudgegonga BBN group meetings to discuss the final results of the PDS and answer any questions. Brief update of results was disseminated in the Agriculture Victoria's email list – Newsflash – Beef and Sheep Network (Appendix 7)
Year 4 (2025) - Dec	Written producer case studies	MLA channels (The Weekly; Feedback magazine; social channels), WormBoss, Mackinnon Project social channels	Practice change/increase production and profit	A producer case study was included in the Spring 2025 edition of MLA's Feedback magazine – 'Smarter drenching is no fluke'. Meat & Livestock Australia : Feedback magazine : Spring 2025 by Meat... - Flipsnack Pg.24 A second producer case is in Appendix 8
Year 4 (2025) - Dec	Producer fact sheets/guidelines	MLA channels (The Weekly; Feedback magazine; social channels), WormBoss, Mackinnon Project social channels	Management protocols for managing liver fluke in high rainfall areas of northeast Victoria and southern NSW	A producer factsheet was included int he Spring 2025 edition of MLA's Feedback magazine – 'Well timed flukicide pays off' Meat & Livestock Australia : Feedback magazine : Spring 2025 by Meat... - Flipsnack Pg. 23

4.4 Monitoring and evaluation

Seven core producers completed the pre project survey and despite continued effort to get core producers to complete the post project survey, only five completed one. However, there was enough information gained through this and discussion with the core producers to understand knowledge, skills and change in confidence.

There were 16 observer producers who completed a pre project survey and 12 who completed a post project survey. Of the 12 who completed the post project survey, 8 of these also completed the pre project survey and were used in the assessment of a change in knowledge, skills and confidence when managing liver fluke in cattle, as was the discussion from the pre and post focus group discussions.

Three focus groups were held at the start of the project to discuss liver fluke management; notes are in Appendix 9. Two discussion groups were held at the end of the project, with a third planned to occur in early December 2025 after completion of the project, however no notes were recorded from these sessions. Surveys were completed and discussion included the results from the project.

No steering committee meetings were held for the duration of the project. There was ongoing discussion with the three core producers who were involved in the treatment comparison trial. This is what lead to changes in adoption from Year 2 to 3 of the project (change from tricladenbazole use to nitroxynil/clorsulon) and termination of the project in Year 2 on Farm F (overall farm management needed to change due to severe drench resistance resulting in observed welfare impacts on this farm).

4.4.1 Knowledge, skills and confidence

The survey and discussion generated at the three pre-project focus groups and two post-project focus groups were used to assess pre and post project knowledge, skills and confidence in the core and observer producers. **Overall, there was an increase in knowledge in 85% of core producers and 52% of the observer producers in the four key areas assessed** in the pre and post project surveys. These included knowledge of the lifecycle of liver fluke, what time of the year cattle will pick up fluke from pasture, why they drench when they do and why they are using the products they are using (Table 23 and Table 24).

Table 23: The percentage of observer producers who increased or decreased their knowledge or had no knowledge change following the PDS

Knowledge of:	Increased knowledge	No change	Decreased knowledge
Lifecycle	75%	13%	13%
When is fluke most available to livestock?	38%	13%	50%
Why they drench at the times they do?	25%	63%	13%
Why use the drenches they select?	71%	29%	0%

Overall increase in knowledge	**52%**	

Table 24: The percentage of core producers who increased or decreased their knowledge or had no knowledge change following the PDS

Knowledge of:	Increased knowledge	No change	Decreased knowledge
Lifecycle	100%	0%	0%
When is fluke most available to livestock?	60%	20%	20%
Why they drench at the times they do?	100%	0%	0%
Why use the drenches they select?	80%	20%	0%
Overall increase in knowledge	**85%**		

The skills of core and observer producers were assessed through questions such as when do they drench to control liver fluke, what products do they use, do they graze paddocks differently or fence off areas that are conducive to fluke and snail survival and do they monitor for liver fluke infection in their cattle. The skills of the core producers in relation to when they drench, what product they use and if they monitor for liver fluke in their cattle increased because of the result of the PDS (Table 25 and Table 26). The use of nitroxynil/clorsulon increased from 29% to 100% and the use of triclabendazole reduced from 57% to 20%. There was only a slight change in skills because of the project in the observer producer, with an increase from 25% to 33% when asked about their times of drenching. Additionally, there was no obvious change in the selection of which drenches to use, with the use of triclabendazole increasing amongst the observer producers.

When asked if they manage paddocks differently due to liver fluke, such as graze only adult stock in 'flukey' paddocks, the core and observer producer responses were generally very similar in that "all paddocks have flukey areas". Additionally, when asked if they fenced off flukey areas, the general response was that they would have too much land fenced off, reducing their overall grazing area. Therefore, there was no change in grazing management skills obtained through the PDS because producers found that changes to grazing management were too difficult or would impact their enterprise management too much.

Table 25: The percentage of core producers pre and post project for each different assessment of skills

Skills:		Pre project	Post Project
Drench at the correct times?		80%	100%
What products do they use?	**Nitroxynil/clorsulon**	29%	100%
	Triclabendazole	57%	20%
	Closantel	14%	40%
	Clorsulon	43%	43%
Do they graze paddocks differently?	**Yes**	14%	0%
	No	86%	100%
Do they fence off 'flukey' areas?	**Yes**	43%	0%

	No	57%	100%
Do they monitor for liver fluke	**Yes**	57%	100%
	No	43%	0%

Table 26: The percentage of observer producers pre and post project for each different assessment of skills

Skills:		**Pre project**	**Post Project**
Drench at the correct times?		25%	33%
What products do they use?	**Nitroxynil/clorsulon**	21%	22%
	Triclabendazole	57%	78%
	Closantel	0%	0%
	Clorsulon	43%	33%
Do they graze paddocks differently?	**Yes**	0%	30%
	No	100%	70%
Do they fence off 'flukey' areas?	**Yes**	6%	40%
	No	94%	60%
Do they monitor for liver fluke	**Yes**	50%	60%
	No	50%	40%

Producers were asked to rate on a scale of 1 to 10 how confident they were in managing liver fluke (Table 27). **The confidence of core producers increased from 5.8 to 7.6 out of 10** with 80% of producers indicating they felt more confident managing liver fluke compared to the start of the PDS. **The confidence of observer producers increased from 4.9 to 7.6** with 100% indicating that they felt more confident managing liver fluke because of the PDS.

Table 27: Increase in confidence in managing liver fluke of core and observer producers and change in confidence as a result of being involved in the PDS

		Core	**Observer**
Increase in confidence		80%	100%
Average score out of 10	**Pre project**	5.8	4.9
	Post project	7.6	7.6

4.4.2 Practice change of core and observer – intended and actual

Six out of the seven core producers have reported that they will or intend to change from using triclabendazole to control liver fluke pre-winter to nitroxynil/clorsulon after having triclabendazole resistance confirmed on their property (Table 14). The remaining core producer, Farm C, following some drench resistance being identified on their property (triclabendazole still reduced fluke egg counts by 86%) was still going to use triclabendazole in combination with oxfendazole, but will use it in rotation with nitroxynil/clorsulon and a drench containing closantel. Therefore, 100% of the core producers intend to, or have already adopted a change to their management of liver fluke.

Through the end of PDS discussions, a proportion of observer producers acknowledged that triclabendazole resistance was likely to be a problem on their farm too and had indicated that they would intend to perform a drench resistance test on their property or switch to using nitroxynil/clorsulon instead of triclabendazole for their pre-winter drench. One of the biggest concerns for producers, which wasn't captured in the surveys was that nitroxynil/clorsulon has a

long Export Slaughter Interval (ESI) and was expensive and so they would prefer not to use it or found it difficult to fit into their management calendar.

In addition to a change in the use of which drench product the core and observer producers intend to use to control liver fluke, monitoring for fluke using fluke egg counts increased from three out of seven core producers (43%, with one of these monitoring sometimes), to 100% of producers (Table 28). Two of those who said they did not use Fl.ECs to monitor infection used visual assessment, but following the project changed to monitoring with Fl.ECs. In the observer producers, the percentage of producers who would use fluke egg counts to monitor for fluke infections increased from 25% to 50% (Table 29).

Table 28: Percentage of core producers who monitored for fluke infections in their cattle using fluke egg counts pre and post project

	Pre-survey	Post-survey
Yes	29%	100%
Sometimes	14%	-
Did not	57%	-

Table 29: Percentage of observer producers who monitored for fluke infections in their cattle using fluke egg counts pre and post project

	Pre-survey	Post-survey
Yes	25%	50%

5 Conclusion

Liver fluke was prevalent on beef properties in northeast Victoria and southeast NSW like what has been found in dairy properties (Kelley *et al 2020*). The project highlighted the need for producers to monitor for fluke on their property (for example using fluke egg counts or copro-antigen ELISA), rather than routinely drench, with some properties in high rainfall areas having a lower prevalence of fluke compared to what was expected. Without the knowledge obtained through monitoring, producers may be drenching unnecessarily, increasing the cost to their enterprise, and contributing to the drench resistance issues identified in this project and previous studies in dairy cattle (Kelley *et al* 2016).

On farms where fluke is less prevalent, shown through routine fluke egg counts, the need for a pre-winter drench needs to be investigated in more detail. This project demonstrated no advantage in productivity or profitability during the winter/early spring period, when a pre-winter drench was given compared to when no drench was given on the farm where fluke egg counts were low.

Poor management of liver fluke in cattle in northeast Victoria and southeast NSW may be causing losses in productivity and profitability on farm with moderate to high fluke egg counts. Incorrect timing of the administration of the pre-winter drench may be resulting in production losses such as reduced weight gains of between 10 to 15.1% in weaner cattle over the winter/early spring period, when feed is limiting. Incorrect timing of the pre-winter drench could be costing the beef industry between $5 to $10 per DSE.

Resistance to triclabendazole, a drench product used routinely by 57% of producers involved as core or observer producers and widely by the industry, was detected on 100% of the core producer's farms. The impact that drench resistance was having on productivity and profitability could not be

determined through this project. However, 100% of core producers were intending to adopt a change in their use of triclabendazole by either switching to the use of nitroxynil/clorsulon, found to be effective on all farms, or using monitoring to enable a more informed decision to be made on whether to treat with triclabendazole in a given year.

There were three gaps in knowledge that were highlighted in this project. Firstly, what impact drench resistance is having on productivity, secondly, what impact liver fluke is having on productivity, especially on farms which have low fluke egg counts, and thirdly, appropriate monitoring protocols that can be adopted to inform drenching decisions.

5.1 Key Findings

- Fluke is present in northeast Victoria and southeast NSW but not on all properties where environmental conditions favour liver fluke development, therefore producers need to monitor for fluke on their farm rather than routinely drench, because they may be treating for fluke, unnecessarily increasing resistance to the drench and cost to the enterprise.
- Drench resistance to triclabendazole was present on all seven properties it was tested on; however, the impact of resistance could not be determined through the project.
- There was a disadvantage in weaners, over the winter/early spring period, that did not receive a pre-winter drench compared to weaners that did on farms with high egg counts.
- Appropriate timing of the pre-winter fluke drench is not the same on every farm, and drenching in April may be too early on most farms with continued fluke pick-up following this treatment, which may have an impact on growth and profitability.

5.2 Benefits to industry

The results from this project have practical application to the red meat industry for the below reasons:

- The timing of the pre-winter drench may have an impact on the kilograms of beef produced per hectare over the winter spring period on farms with high fluke egg counts. By optimising the timing of the pre-winter drench producers may increase their enterprise gross margin by up to $10/DSE and reduce the cost of production by $0.25/kg red meat.
- Despite no production impact identified in this project because of resistance to triclabendazole, the confirmation of resistance on producer's farms is still important to enable producers to make informed decisions about which drench product to use as their pre-winter drench. With limited drenches available to kill immature fluke in cattle (and sheep), it is important to the wider beef and sheep industry to be aware of drench resistance and use drenches more strategically to prolong the effectiveness of these drenches.
- Insights from this project also confirmed that liver fluke would have an impact on production if left untreated on farms where liver fluke is prevalent, with a reduction in productivity of 23 kg/ha, which equated to an impact on gross margin of $11/DSE.
- Improved monitoring for fluke infections through fluke egg counts or copro-antigen ELISA is a tool that more producers in the red meat industry need to adopt rather than routine drenching. Effective monitoring will equip producers with more information about when they need to drench, increasing productivity, and if they need to drench, reducing the costs to the enterprise by avoiding unnecessary drenches.

By combining monitoring, improved timing of drenches and strategic informed use of drench products, the benefit to the wider beef industry would include economic benefits at farm level, as well as benefiting processors with an increased slaughter liveweight spread over the same processing cost. It would also benefit the industry in the longer-term with reduced loss of offal value, estimated to cost the beef industry $12 to 49 million annually.

Challenges identified in this project included:

- Not enough farms identified with fluke or high enough fluke egg counts to be included in the project.
- The practicality of using fluke egg counts to time pre-winter drenches when it is only monitoring adult infection in cattle.

6 References

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7 Appendix

7.1 Appendix 1

7.1.1 Sampling protocol

Cattle age: Ideally weaners/yearling

1. In the paddock, allow cattle to crowd around the vehicle quietly.
2. After 15 minutes, collect 1 handful of faeces from a fresh cow pat (important that it is a fresh cow pat).
3. Place sample into a zip lock bag and ensure the bag is properly sealed.
4. Repeat this with 10 separate fresh cow pats (important that they are separate samples), using separate gloves for each sample.
5. Place the 10 zip lock bags containing separate samples inside the large zip lock bag.
6. Fill out the submission form and place this inside a small zip lock bag before placing inside the large zip lock bag with the samples.
7. Place the large zip lock bag, containing 10 x samples and 1 x submission form inside the express post bag and post ASAP. If you can't post the samples that day, place them in the fridge until you can post it.

If you have any concerns or questions, please don't hesitate to call on

0417 038 758, or email at ldtyrell@unimelb.edu.au

Many thanks,

Leah Tyrell

7.2 Appendix 2

7.2.1 Communication plan

Communications plan – Optimising Liver Fluke Management in Cattle

This communications plan template provides guidance for Meat & Livestock Australia's program partners who have been requested to develop a communications plan as part of their project deliverables.

Prepared by:

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Background

Liver fluke infection is widespread in cattle and sheep across high rainfall areas (>600 mm) of south-eastern Australia and other irrigated areas. Due to the lifecycle of liver fluke and its reliance on a snail to complete the lifecycle, eradication is impossible. Therefore, control and prevention of disease through grazing management and strategic flukicide (drench) use are important. However, the reliance on the drench called triclabendazole, and the increasing resistance to this drench is of concern.

Across areas of Australia where fluke is widespread, including most of Victoria and south-eastern NSW, up to 40 million sheep and 6 million cattle graze. A recent study using tests to diagnose liver fluke showed that in dairy herds in six different irrigation areas across Victoria liver fluke is common, but the question remains as to its occurrence in beef cattle because they are managed differently and often graze different country.

Impacts on cattle commonly associated with liver fluke include death, weight loss, reduced feed conversion and reduced reproductive performance. Work in the 1970s demonstrated that young stock infected experimentally with liver fluke had an 8 to 27% reduction in growth rate.

Resistance to triclabendazole has become a worldwide problem as this chemical has been used to control liver fluke since the 1980s. Australia is no exception, with liver fluke resistance to the chemical detected in Victoria around the mid-1990s. Many farmers are still relying heavily on this chemical placing further pressure on this already failing drench. Data collected from dairy farms between 2014 and 2016 indicated the presence of resistance to triclabendazole in Victoria and indicated that it may have been contributing to the high occurrence of fluke on some properties, thus impacting the overall animal wellbeing and hence production.

Challenge/opportunity

Due to the lifecycle of liver fluke and its reliance on a snail to complete the lifecycle, eradication is impossible. Therefore, control and prevention of disease through grazing management and strategic flukicide use are important. However, despite producers knowing that liver fluke is present on their property, and treat for it, they and some consultants don't fully understand the complex lifecycle of liver fluke, meaning they don't fully understand the reasoning behind strategic drenching, the type of product to use at different times of the year and when these treatments would occur in their environment.

The aim of this PDS is to improve the productivity and sustainability of beef production, by optimising producers' management protocols of liver fluke through the demonstration of its prevalence, and the presence of drench resistance.

Target audience

The target audience for this project are producers in the high rainfall areas (>600 mm) of Northeast Victoria and Southeast NSW, where liver fluke is endemic. This audience would prefer to receive their information through face to face field days and information disseminated through their better beef groups.

Key messages

Key messages I wish to communicate to producers:

- Information about liver fluke
    - Lifecycle, impact on production, importance in the cattle and sheep industry, strategic management, drench products available and drench resistance

- Information about the proposed method and timeline for the PDS
- Update on results from the first year
    - Present results from the egg counts and where liver fluke is prevalent
    - Results from the drench resistance test, used to determine if some drenches aren't effective
- Update on results from the 2nd and 3rd year of the project
    - Present results on weight, egg count and livestock data link from each of the comparison groups involved
- Present summary of the results from the project and ideal management protocol for management of liver fluke, identified from this PDS, including:
    - Strategic use of effective drenches
    - Grazing management
    - Improved and more targeted monitoring of liver fluke

Outcome/KPIs

By March 2026, in north-east Victoria and south-east New South Wales:

1. Estimate the prevalence of liver fluke in beef cattle by conducting fluke egg counts on faeces collected from cattle on three to five core and 30 observer producer farms
2. Determine the prevalence of liver fluke drench resistance to triclabendazole by fluke faecal egg counts on core producer properties and/or on observer producer properties where fluke has been identified through the prevalence survey
3. Using focus groups with core and observer producers, record their current protocol for controlling liver fluke in cattle, including use of drench, monitoring and environmental control (eg. fencing off 'flukey' areas)
4. Set up three different treatment/monitoring protocols for the control of liver fluke in cattle on three to five core farms with known liver fluke, and demonstrate the effects on:
    a. Weight gain in young stock - show any increase in growth rate in the 6-month period following treatment
    b. Fluke faecal egg counts (used to monitor infection), and
    c. Livestock Data Link for abattoir feedback (used to monitor infection).
5. 100% of core producers and 50% of observer producers will have increased their knowledge and confidence in managing liver fluke
6. Seventy-five percent of core producers and 50 percent of the observer producers will intend to adopt/or change their current management with revised treatment, monitoring and control protocols in their area
7. Conduct a workshop with the core and observer producers to discuss the results of the prevalence survey and drench resistance results.

Conduct an end of PDS field day to showcase the treatment, monitoring and control protocol demonstration results to 50 producers in north-east Victoria and south-east NSW.

Channel/timing matrix

Timing	Communications tactics (e.g. written producer case study, video)	Communications channel (e.g. Feedback magazine, media release)	Messages
Year 1			

Year 1 (2022) – 31st May	Start of PDS field day	Presentations presented by Leah Tyrell and Ben Blomfield both of the Mackinnon Project	Liver fluke: Lifecycle, disease and strategic management Drenches and drench resistance Information on the PDS
Year 2			
Year 2 (2023) –Jan	Field day	Presentations and hand outs Presentations via Leah Tyrell and other Mackinnon Project consultants.	Update from prevalence survey/drench resistance testing
Year 2 (2023) – Feb	Written article	Mackinnon newsletter, MLA channels (The Weekly; Feedback magazine; social channels)	PDS outline and an update on the results of year 1 of the PDS
Year 2 (2023) – Feb	Written communication	Leah Tyrell will email an update of results to BWBL and BBN coordinators who will disseminate to their members, Mackinnon Project social channels	PDS outline and an update on the results of year 1 of the PDS
Year 4			
Year 4 (2025) - Jun	End of PDS field day	Presentations and hand outs Presentations via Leah Tyrell and other Mackinnon Project consultants.	Summary of finding from the comparison trials and recommendation for optimal management of liver fluke in cattle
Year 4 (2025) - Jul	Written article	Mackinnon newsletter, MLA channels (The Weekly; Feedback magazine; social channels)	Update on the results of year 2 and 3 of the PDS
Year 4 (2025) - Jul	Written communication	Leah Tyrell will email an update of results to BWBL and BBN coordinators who will disseminate	Update on the results of year 2 and 3 the PDS

		to their members, Mackinnon Project social channels	
Year 4 (2025) - Dec	Written producer case studies	MLA channels (The Weekly; Feedback magazine; social channels), WormBoss, Mackinnon Project social channels	Practice change/increase production and profit
Year 4 (2025) - Dec	Producer fact sheets/guidelines	MLA channels (The Weekly; Feedback magazine; social channels), WormBoss, Mackinnon Project social channels	Management protocols for managing liver fluke in high rainfall areas of north east Victoria and southern NSW

Implementing the plan

Leah Tyrell the Work Leader

7.3 Appendix 3

7.3.1 Monitoring and evaluation plan

1. Objective

By March 2026, in northeast Victoria and southeast New South Wales:

1. Estimate the prevalence of liver fluke in beef cattle by conducting fluke egg counts on faeces collected from cattle on three to five core and 30 observer producer farms
2. Determine the prevalence of liver fluke drench resistance to triclabendazole by fluke faecal egg counts on core producer properties and/or on observer producer properties where fluke has been identified through the prevalence survey
3. Using focus groups with core and observer producers, record their current protocol for controlling liver fluke in cattle, including use of drench, monitoring and environmental control (eg. fencing off 'flukey' areas)
4. Set up three different treatment/monitoring protocols for the control of liver fluke in cattle on three to five core farms with known liver fluke, and demonstrate the effects on:
    a. Weight gain in young stock - show any increase in growth rate in the 6-month period following treatment
    b. Fluke faecal egg counts (used to monitor infection), and
    c. Livestock Data Link for abattoir feedback (used to monitor infection).
5. 100% of core producers and 50% of observer producers will have increased their knowledge and confidence in managing liver fluke
6. Seventy-five percent of core producers and 50 percent of the observer producers will

intend to adopt/or change their current management with revised treatment, monitoring and control protocols in their area

7. Conduct a workshop with the core and observer producers to discuss the results of the prevalence survey and drench resistance results.
8. Conduct an end of PDS field day to showcase the treatment, monitoring and control protocol demonstration results to 50 producers in north-east Victoria and south-east NSW.

2. Business drivers addressed

	Performance Metrics		
Productivity (select at least one metric)	Production efficiency (Kg red meat / ha)		**√**
	Production efficiency (kg red meat /dse)		**√**
	Reproductive efficiency (heifer pregnancy %)		**√**
	Other, please list ……..		
Profitability (select at least one metric)	Enterprise Indicators	Cost of Production ($/ kg red meat)	**√**
	Other, please list……..		

Evaluation level	**Project performance measures**	**Evaluation methods**
Inputs – What did we do?	• 3 on-farm demonstration sites appointed at beginning of the project, with 2 more appointed following results of the prevalence survey • 30 observers covering 12,000 head of cattle and 3,000 head of sheep • Area: total area under management of the core and observer producers is 18,000 ha • Eight focus group meeting with core and observer producers (two in each area, one at the start and one at the end) – steering committee appointed following the first focus group	• Notes of input discussions from focus group and steering committee • Financial records • Documentation of all PDS activities
Outputs – What did we do?	• New and updated data of the presence of liver fluke in cattle across Northeast (NE) Victoria and Southeast (SW) NSW. • New data on liver fluke resistance to triclabendazole drench. The metrics being measured to assess the impact drench resistance has on enterprise and industry performance include: o Liveweight gain in weaner cattle (kg/hd/day)	• Data from prevalence study and drench resistance trial, and metrics used in comparison trials stored in central data base and documented in milestone reports

Evaluation level	Project performance measures	Evaluation methods
	○ Livestock Data Link feedback from abattoirs • Improved knowledge on management of liver fluke in cattle in NE Vic and SE NSW. The metrics being measured to assess the impact poor management has on enterprise and industry include: ○ Liveweight gain in weaner cattle (kg/hd/day), ○ Pregnancy rates in heifers (%), and ○ Livestock Data Link feedback from abattoirs • Performance metrics to demonstrate the impact of adoption include: ○ Production efficiency (kg red meat/DSE) ○ Income ($/DSE) ○ Costs ($/DSE) ○ Net profit ($/DSE) ○ Cost of production ($/kg red meat) ○ Reproductive efficiency (heifer pregnancy rate) • Annual field days targeting at least 50 producers managing about 20,000 head of cattle and 5,000 head of sheep • Annual Mackinnon Project seminar targeting at least 50 Mackinnon Project clients • Extension and communication of new knowledge through: ○ At least three articles for Mackinnon Project newsletter, One factsheets for MLA online, and ○ Development of two case studies for MLA and ParaBoss • Ongoing communication and updates via social media (Twitter and Facebook)	• Copies of newsletters, case studies and factsheets • Summary of field day and seminar attendance • Social media activity recorded
Changes in knowledge attitudes and skills – How well did we do it?	• One hundred percent of core producers and 50% of observer producers will increase their knowledge and confidence in managing liver fluke • Focus group used to attain skills/knowledge/attitude/thoughts at the start and end of the PDS.	• Pre and post project surveys • Notes and summary of results from focus groups at the commencement and end of PDS • Case studies of producers involved in the PDS

Evaluation level	Project performance measures	Evaluation methods
		• Longer term surveys conducted by MLA (secondary impact information)
Practice changes – Has it changed what people do?	• Seventy-five percent of core producers and 50% of the observer producers will intend to adopt/or change their current management with revised treatment, monitoring and control protocols in their area	• Pre and post project surveys • Notes and summary of results from focus groups at the commencement and end of PDS • Notes and summary of results from steering committee groups at the end of each year
Benefits – Is anyone better off?	• Core and observer producers will be more aware of the presence of liver fluke on their property and in their region, enabling more strategic management of liver fluke • Both the cattle and sheep industry will benefit with increased knowledge on strategic use of flukicides. This will place less pressure on the development of resistance, particularly triclabendazole. • Increase in growth rates – 8 to 27% increase which will result in an increase in kg beef produced per hectare • Reduced animal health costs due to more informed decisions about fluke and worm treatments • Processors benefit from increase in slaughter weight over same processing cost • Industry benefits from reduced costs due to loss of offal, which is estimated to cost the industry $10 to 49 million annually. • Improved meat eating quality • Benefits and costs	• Data will be recorded from core and observer producers for the prevalence survey • Data, Fluke Egg Counts (Fl.EC) and weights, will be recorded from the Fluke Egg Count Reduction Trial (Fl.ECRT) and a comparison on the effectiveness of each drench analysed • Data, Fl.EC, growth rate, heifer pregnancy rate and abattoir feedback (Livestock Data Link (LDL)) will be recorded and used to determine the effectiveness of each treatment in the comparison trial. • Farmer to keep records of fluke and

Evaluation level	Project performance measures	Evaluation methods
		worm treatments given and this information collected by the researcher to record • Data from abattoir feedback (LDL) – collected retrospectively and at the end of the Fl.ECRT and the end the two comparison trials • Meat Standards Australia (MSA) team to link the animal health data with eating quality data
General observations/outcomes – Is the industry better off?	• Cattle and sheep industry benefits seen by reduced costs due to liver fluke; production losses and prevention, improving overall profitability • Performance metrics to demonstrate the impact of adoption on cattle and sheep farms in regions which include: o Production efficiency (kg red meat/DSE) o Income ($/DSE) o Costs ($/DSE) o Net profit ($/DSE) o Cost of production ($/kg red meat) o Reproductive efficiency (heifer pregnancy rate) At the end of the PDS, 75% of core and 50% of observer producers understand the benefit of strategic use of triclabendazole, to improve the longevity of this important flukicide in both the cattle and sheep industry.	• Data from prevalence study and drench resistance trial, and metrics used in comparison trials summarised and reported • Notes and summary of results from focus groups and the steering committee at the commencement and end of PDS • Longer term surveys conducted by MLA (secondary impact information)

7.4 Appendix 4

7.4.1 Treatment comparison trial weights

Table 30: Average weight of each treatment group at each visit for each farm in Year 1 (2023)

Farm	Group	Visit					
		1	2	3	4	5	6
E	1	161.4	171.2	176.6	191.1	193.2	289.8
	2	163.2	172.3	180.0	186.6	193.4	290.8
	3	175.1	184.8	188.1	201.7	212.4	306.3
F**	1	172.8	176.4				
	2	172.6	174.1				
	3	161.3	162.7				
G*	1		238.2		253.5	285.6	374.1
	2		229.1		244.4	284.3	373.2
	3		234.3		252.8	285.8	378.2

*No weight of Fl.EC done at visit 3, **Trial terminated after visit 3, no weight collected at visit 3

Table 31: Average weight of each treatment group at each visit for each farm in Year 2 (2024)

Farm	Group	Visit					
		1	2	3	4	5	6
E	1	156.7	149.7	144.2	145.6	154.8	228.7
	2	161.3	156.8	148.9	147.1	154.5	224.3
	3	158.2	151.7	146.3	143.3	152.3	221.9
F	1	151.9	166.9	153.1		157.0	227.3
	2	145.9	162.6	155.8		161.5	234.1
	3	145.3	162.1	148.9		153.3	223.2
G	1	242.7	245.0	251.6	262.1	249.2	310.5
	2	239.75	240.8	250.8	259.6	248.9	300.8
	3	243.6	247.4	258.4	265.2	249.2	304.0

7.5 Appendix 5

7.5.1 Workshop/seminar flyers

Producer Demonstration Site

mla MEAT & LIVESTOCK AUSTRALIA

You're invited

Liver fluke management in cattle and making informed decisions while fertiliser and land prices are high

Producer Demonstration Site (PDS) – field day

What	**Information field day**
When	**31 May 2022 | 9.30am to3pm | Lunch provided**
Where	**Mudgegonga Hall**
	1395 Myrtleford-Yackandanda Road, Mudgegonga, Victoria

MLA's PDS program supports producers to adapt, validate and demonstrate the business value of integrating new management practices and skills into their local farming systems.

Overview of the Producer Demonstration Site

This PDS aims to:

- test for the presence of liver fluke in cattle on farms in high rainfall regions of north east Victoria and southern NSW
- identify if there are farms which have liver fluke that is resistant to a common drench used for its control
- demonstrate and educate producers on optimal strategic management of liver fluke through demonstration sites, focus groups and information field days.

What's on the agenda?

- Impact liver fluke has on production and its strategic management – Leah Tyrell (Mackinnon Project)
- Drenches available to control liver fluke and drench resistance – Leah Tyrell/ John Webb Ware (Mackinnon Project)
- About the Producer Demonstration Site project – Leah Tyrell (Mackinnon Project)
- Soil testing, making informed fertilizer decisions, introduction to the DecipherAg – Sue Briggs (CSBP)
- Return on investment for fertiliser application with high prices – John Webb Ware (Mackinnon Project)
- How much is my farm worth and do I sell, lease or buy? – John Webb Ware (Mackinnon Project)

To RSVP or for more information

Leah Tyrell **P:** 0417 038 758 **E:** ldtyrell@unimelb.edu.au

This event is funded by Meat & Livestock Australia with the support of The Melbourne University Mackinnon Project.

MACKINNON

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MACKINNON PROJECT

SHEEP AND BEEF CATTLE HEALTH AND PRODUCTION MANAGEMENT SERVICE

THE UNIVERSITY OF MELBOURNE

Mackinnon Project Seminar Series

Seminar 1* – Management During Challenging Times

Monday, 11 December 2023, 9.00 am to 3.00 pm

Northeast Victoria – Sandy Creek Memorial Hall

464 Lockharts Gap Road, Charleroi

Cost: Free – includes morning tea and lunch

Registrations: Contact Leah Tyrell: 0417 038 758; ldtyrell@unimelb.edu.au or
Elysia Ling: 0406 728 922; elysia.ling@unimelb.edu.au or
Chris Mirams: 0409 205 235

RSVP: by Wednesday 6 December

PROGRAM

ARRIVAL AND MORNING TEA	**9.00 am**
WELCOME	**9.30 am**
SESSION 1 – Changing Management with Low Commodity Prices	**9.40 am**
John Webb Ware – Mackinnon Project	
SESSION 2 – Is This Dry Period Different to Others?	**10.20 pm**
Daniel Brookes – Mackinnon Project	
SESSION 3 – Update on Mackinnon Project Activities	**11.00 am**
MLA Producer Demonstration Site update – Liver Fluke management in cattle	
Results from liver fluke drench resistance trials and time of treatment demonstrations	
Leah Tyrell – Mackinnon Project	
Cattle Worms – How widespread is drench resistance and is it getting worse?	
Ben Blomfield – Mackinnon Project	
Fine tuning your calving time – bigger progeny or less feeding?	
Georgie Champion de Crespigny / John Webb Ware – Mackinnon Project	
LUNCH	**12.30 pm**
SESSION 4 – Irrigation – A Tool to Mitigate a More Variable Climate?	**1.10 pm**
Dennis Watson (Irrigation Specialist) – Agriculture Victoria	
CLOSING DISCUSSION AND FINISH	**3.00 pm**

*Next seminars in Feb 2024 – locations to be confirmed

This event is funded by Meat & Livestock Australia with the support of The Melbourne University Mackinnon Project

Producer Demonstration Site

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MACKINNON PROJECT

SHEEP AND BEEF CATTLE HEALTH AND PRODUCTION MANAGEMENT SERVICE

Mackinnon Project Seminar Series

Seminar 2 – Management During Challenging Times

Wednesday, 23 October 2024, 9.00 am to 2.30 pm

Western Victoria –Warrambeen Landcare Education Centre

Rokewood Road, Shelford

Cost: Free – includes morning tea and lunch

Registrations: mackinnon-project@unimelb.edu.au;
or Leah Tyrell on 0417 038 758

RSVP: by Friday 18 October

PROGRAM

ARRIVAL AND MORNING TEA	**9.00 am**
WELCOME	**9.30 am**
SESSION 1 – What is Driving the Weather?	**9.40 am**
Dale Gray – Agriculture Victoria	
SESSION 2 – Decision Making for Droughts – Are We Going Around Again?	**10.20 am**
John Webb Ware	
SESSION 3 – Update on Mackinnon Project Activities	**11.00 am**
Ben Blomfield – MLA Producer Demonstration Site Update – Drench Resistance in Cattle Worms	
SESSION 4 – Reviewing Recent Drought Management – The Dos and Don'ts	**11.20 am**
John Webb Ware	
LUNCH	**12.00 pm**
SESSION 5 – What Impact Does Drought Have on Commodity Prices	**12.40 pm**
Leah Tyrell	
SESSION 6 – Update on Mackinnon Project Activities	**1.20 am**
Leah Tyrell - MLA Producer Demonstration Site Update – Drench Resistance in Liver Fluke	
Daniel Brookes – Recommended time of calving across southern Australia	
Leah Tyrell - Cost:Benefit tool for transitioning to a non-mulesed flock	
CLOSING DISCUSSION AND FINISH	**2.00 pm**

This event is funded by Meat & Livestock Australia with the support of The Melbourne University Mackinnon Project

Producer Demonstration Site

MEAT & LIVESTOCK AUSTRALIA

Date: 18th November 2024

Time: 12.30pm to 4.30pm Lunch included

Location: Art Parts Gallery 488 David Street, Albury

Breeding Decisions

- Increasing selection capability using Angus HeiferSelect
- Should I AI my commercial heifers?
- Should I breed my own bulls?
- Does genetic gain always lead to increased profit?

Management Decisions

- How do poor seasons influence commodity prices including beef, hay and grain?
- Reviewing decision making in tough seasons.
- Updates on the liver fluke PDS and drench resistance in cattle worms PDS.

RSVP

chrisjmirams@gmail.com

Guest Speakers

- Jake Bourne - Zoetis
- John Webb-Ware – Mackinnon Project
- Ben Blomfield - Mackinnon Project
- Leah Tyrell - Mackinnon Project
- Dane Skinner – Big Springs commercial cattle producer

Brought to you by the
North East Genomics Group

Producer
Demonstration Site

MACKINNON PROJECT

SHEEP AND BEEF CATTLE HEALTH AND PRODUCTION MANAGEMENT SERVICE

Mackinnon Project Seminar

Smart Recovery, Smart Decisions – Pasture, Parasites and Profit

Wednesday, 27th August 2025, 9.30 am to 2 pm

Mudgegonga Community Hall, 1395 Myrtleford-Yackandandah Road, Mudgegonga

Cost: Free – includes morning tea and lunch

Registrations: mackinnon-project@unimelb.edu.au;
or Leah Tyrell on 0417 038 758

RSVP: by Friday 22nd of August

PROGRAM

ARRIVAL AND MORNING TEA	**9.30 am**
WELCOME	**10.00 am**
SESSION 1 – Review of Drought Management and Fodder Reserves *Ben Ashton*	**10.30 am**
SESSION 2 – Getting Pastures Back in Business *John Webb Ware*	**11.00 am**
SESSION 3 – Update on Mackinnon Project Activities *Ben Blomfield – MLA Producer Demonstration Site Update – Drench Resistance in Cattle Worms* *Leah Tyrell – MLA producer Demonstration Site Update – Liver Fluke Management* *Georgie Champion de Crespigny – Time of Calving Modelling for Different Regions*	**11.30 am**
LUNCH	**12.30 pm**
SESSION 4 – Leasing the Farm Next Door – How Much to Pay? *John Webb Ware*	**1.10 pm**
SESSION 5 – Case Study on Drench Resistance in Sheep *Ben Blomfield*	**1.40 pm**
CLOSING DISCUSSION AND FINISH	**2.00 pm**

This event is funded by Meat & Livestock Australia with the support of The Melbourne University Mackinnon Project

Producer Demonstration Site

MEAT & LIVESTOCK AUSTRALIA

7.6 Appendix 6

7.6.1 Mackinnon Project newsletter articles

MLA Producer Demonstration Site – Optimising Liver Fluke Management in Cattle

Dr Leah Tyrell BVSc MVSc

Liver fluke infection is widespread in cattle and sheep across high rainfall areas (>600 mm) of south-eastern Australia and other irrigated areas. Due to the lifecycle of liver fluke and its reliance on a snail to complete the lifecycle, eradication is near impossible. Therefore, control and prevention of disease through grazing management and strategic flukicide use are important. However, the reliance on the anthelmintic triclabendazole (TBZ), and the increasing resistance to this chemical is of concern.

Across areas of Australia where fluke is endemic, including most of Victoria and south-eastern NSW, up to 40 million sheep and 6 million cattle graze. A recent study using faecal egg counts and coproantigen ELISA showed that the individual animal prevalence of liver fluke in dairy cattle in six different irrigation areas across Victoria was 39%, with 46% of the herds which took part in the study likely to be experiencing production losses associated with liver fluke (Kelley *et al.* 2016).

Losses associated with Liver Fluke

Production losses commonly associated with liver fluke include mortality, weight loss, reduced wool growth in sheep and reduced reproductive performance. Additionally, loss of meat and offal value due to animal health and disease costs the industry $12 to 49 million annually. In 2022, Shephard and others estimated that the cost of liver fluke to the Australian sheep industry was about $38.5 million annually. There have been no recent documented costs to the Australian beef industry, however infection is associated with lower growth rates and feed conversion ratios in fattening cattle. This can have an impact on slaughter weight as well as replacement heifers' critical mating weight. Work in the 1970s demonstrated that young stock infected experimentally with liver fluke had an 8 to 27% reduction in growth rate (Hope Cawdrey *et al.*1977).

Resistance to TBZ has become a worldwide problem as this chemical has been used to control liver fluke since the 1980s. Australia is no exception, with resistance detected in Victoria around the mid-1990s. Many farmers are still relying heavily on this chemical placing further pressure on this already failing flukicide. Data collected from dairy farms between 2014 and 2016 indicated the presence of resistance to TBZ in Victoria and indicated that it may have been contributing to the high prevalence of fluke in some properties, thus impacting the overall productivity.

MLA Producer Demonstration Site Project

In response to producer concerns about managing liver fluke, and the increasing presence of resistance to TBZ, Mackinnon Project is undertaking a Meat and Livestock Australia (MLA) Producer Demonstration Site (PDS) project. The aim of the project is to improve the productivity and sustainability of beef production, by optimising producers' management protocols of liver fluke. This will be through the demonstration of fluke being present on farms, as well as demonstrating the presence of drench resistance.

Starting this year, four to five demonstration sites will be set up in north east Victoria and south east NSW. On these farms, weaner cattle will be divided into three treatment groups. The first treatment group will be managed for liver fluke as would normally occur on that farm. The second and third treatment groups will be given either an early winter drench for liver fluke or a late winter drench. All three groups will be compared on bodyweights and fluke egg counts in the four to six months following treatment. If possible, these weaners will also be following through to slaughter. The demonstration sites will be set up over two consecutive years using two different cohorts of weaners.

In addition to the comparison trial outlined above, eight fluke egg count reduction trials will be set up on farms across the same area.

If you would like more information about the PDS or liver fluke, or would like to be involved, please contact Leah Tyrell on 0417 038 758 or email ldtyrell@unimelb.edu.au

Key points:

- ***Liver fluke management is often suboptimal due to the complex lifecycle of the fluke***
- ***Liver fluke is associated with production losses in cattle and sheep, such as reduced growth rates in young cattle***
- ***Triclabendazole resistance in a growing concern***
- ***Mackinnon Project is running an MLA Producer Demonstration Site to help producers manage liver fluke more strategically***

Nov/Dec 2023

MLA Producer Demonstration Site – Optimising Liver Fluke Management in Cattle – Preliminary Results

Dr Leah Tyrell BVSc (Hons) MVSc

In response to producer concerns about managing liver fluke, and the increasing presence of resistance to triclabendazole, the Mackinnon Project is undertaking a Meat and Livestock Australia (MLA) Producer Demonstration Site (PDS) project with an aim to improve productivity and sustainability of beef production, by optimising producers' management of liver fluke. This will be through the demonstration of fluke being present on farms, as well as demonstrating the presence of drench resistance.

Refer to the Nov/Dec 2022 newsletter, which outline the project and summarises information about production impacts of fluke, and the emerging issue of drench resistance to triclabendazole. This article will summarise the activities carried out in 2023, and associated results.

MLA Producer Demonstration Site

The PDS consisted of four components, which are listed below:

Part 1: Assessing producers' attitude, knowledge, and skills in relation to managing liver fluke

Part 2: Monitoring of liver fluke infections

Part 3: Detection of drench resistance

Part 4: Comparison of time of flukicide treatment

Part 1: Producers' attitude, knowledge, and skills

To assess producers' attitude, knowledge, and skills in relation to liver fluke management, focus groups and surveys were utilised. Twenty-one producers were surveyed from NE Victoria and SE slopes of NSW, and a range of responses were collected with the results summarised below.

A large proportion of the respondents were confident that liver fluke was present on their property (17/21). Of the respondents, only seven observed any production impacts due to liver fluke such as, reduced weight gain, weight loss and mortalities.

Respondents were asked about their knowledge of the liver fluke lifecycle. Knowledge was scored out of 5, with 5 being a thorough understanding. The average score was 1.25 out of 5, with only one respondent showing a thorough understanding of the lifecycle.

When producers were asked about their management of liver fluke, 19 indicated that they drenched in the months of either April, May or June, with a further five indicating they drenched again in August or September. When asked why they drenched cattle for fluke at this time, 14 respondents didn't know why, with responses such as, "I was told to" and "that's when we have always done it". Four respondents had a moderate understanding with responses such as, "to target immatures and mature adults in autumn, and adults in August" and "(I) like to have a couple of heavy frosts (before treatment) so there is no more pick up (after treatment)".

There was a range of products that were used to control liver fluke. Ten used products containing triclabendazole, five used Nitroxynil/clorsulon products and ten used a product that was in combination with a 'mectin (eg. ivermectin/clorsulon pour-on). Respondents were asked why they used these products, and only five had a moderate understanding of why they used the product they chose.

Respondents were asked about grazing management to manage liver fluke. Only two indicated they grazed

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paddocks differently, and five indicated they fenced of "flukey" areas such as springs.

About half of the respondents monitored for fluke infections through fluke egg counts and 18 respondents were unsure if drench resistance to products that killed liver fluke was present on their property.

At the conclusion of the PDS, producers will be asked similar questions to determine if the PDS has had an impact on their management of liver fluke in cattle.

Part 2: Monitoring of fluke burdens

Faecal collection for fluke egg counts were conducted by producers on 20 farms across NE Victoria and SE slopes of NSW. They were instructed to collect 10 x fresh faecal samples in the paddock, and send these to The University of Melbourne in Werribee for fluke egg counts via the flotation method.

Twelve out of the 20 farms sampled (60%) had evidence of fluke infection in their cattle. The average fluke egg count across these farms was 6.5 eggs per gram (epg) of faeces, with the highest average being 60.5 epg. The farm with this high count had an individual animal count as high as 345 epg. All ten animals sampled had evidence of a fluke infection on this farm.

There were three out of the 20 farms sampled where all ten animals sampled had a positive egg count. On the farms where fluke was present, an average of at least half (5 out of 10) of the animals tested had evidence of a fluke infection.

Not unexpectedly, the location of farms which had fluke infections present in their cattle were in areas with higher rainfall and had country that was ideal for the intermediate host (snail) and liver fluke to complete their lifecycles, eg. springs.

Following monitoring, there were a few producers who were surprised that there was no fluke identified in their cattle. This was despite the farm being located in an environment ideal for liver fluke, and several feacal submissions being made. After discussions with these producers, it was identified that they have been strategically controlling fluke of several years, successfully reducing the population of liver fluke on their property.

Table 1: Activities that occurred at each visit

Visit 1	Visit 2	Visit 3
Day -7	Day 0	Day ~28
Sampled and weighed	Drenched and weighed	Sampled and weighed

Part 3: Detection of drench resistance

To detect drench resistance, fluke egg count reduction trials were set up. Trials were set up on four farms, with 45 weaners allocated into three groups, as listed below

Group 1: Control (no treatment)

Group 2: Oral triclabendazole

Group 3: Nitroxynil/clorsulon injection

Note: Three extra farms from the trials set up in Part 4 are included in these results (Farms A to C in Table 2).

Bodyweights of all animals were also collected to determine if there were any production impacts due to drench resistance.

Table 1 indicated the sequence of visits and activities that occurred at each visit, and the results are summarized in Table 2.

There was resistance to triclabendazole present on all farms, with the percent reduction ranging from 0 to 86%. The confidence intervals around these reductions are very wide due to the low egg counts, however it still indicates that triclabendazole is not reducing the fluke egg counts to 0 epg.

Table 2: Results from the fluke egg count reduction trials conducted on Farms A to G.

Farm	Eggs per gram of control group at Visit 3	% Reduction – Oral triclabendazole	% Reduction – Nitroxynil/clorsulon
A	2.5	86%	-
B	23	0%	-
C	6	0%	-
D	11	82%	100%
E	43	50%	99%
F	14	67%	93% (only 4 epg)
G	15	0%	100%

There was no significant weight difference between Group 2 or 3, and Group 1 (Table 3), although the general trend indicated that animals in Group 3, which were treated with an effective product (Nitroxynil/clorsulon), had a greater weight gain than Group 1, which wasn't treated at all. Group 2 was not as heavy as Group 3, at the end of the trial, which may reflect drench resistance, however, it is hard to determine if this was the case with such low egg counts.

Any weight advantage was hard to determine over the short period of time that the trial was conducted (28 days). In addition, the trials were conducted over winter when growth rates are normally low anyway.

Table 3: A comparison of weight differences (kg) between Group 2 or 3, and Group 1

Farm	Group 2 (Oral triclabndazole)	Group 3 (Nitroxynil/clorsulon)
D	+ 2.67	+ 4.80
E	+ 1.46	+ 1. 93
F	- 1.09	+ 1.99
G	+ 1.14	+ 0.36

Part 4: Comparison of time of treatment trial

One of the objectives of the PDS was to demonstrate if different treatment times effects weight gains and fluke egg counts, and compare this to what producers are currently doing to manage liver fluke.

Three farms were included in Part 4 of the PDS. On each farm, 60 weaners were randomly selected from the cohort of weaners on the property. The weaners were randomly allocated into 1 of 3 groups. The groups were;

Table 4: Activities that occurred at each visit

Visit 1	Visit 2	Visit 3	Visit 4	Visit 5	Visit 6
April	May	June	August	September	November
Start - Weighed, allocated	**Drenched** and sampled Group 2, Weighed all	Sampled Group 2, weighed all	**Drenched** and sampled Group 3, weighed all	Sampled Group 3, weighed all	Finish - Sampled and weighed all

Group 1: Farmer's normal management of fluke

- Farm A – Nitroxynil/clorsulon in May
- Farm B – Oral triclabendazole in May
- Farm C – Pour-on triclabendazole in May

Group 2: Late autumn/early winter treatment with oral triclabendazole (May)

Group 3: Late winter treatment with oral triclabendazole (August)

The activities that occurred at each visit are in Table 4.

Table 5 shows the average weight gains from the start to the finish for Groups 2 and 3, and the differences compared to Group 1 (in brackets). Farm B is not included in the results in Table 5 because they pull out of the trial and drenched the weaners with an effective product. This was due to the presence of severe resistance on this farm (Table 2), and that the weaners were suffering.

There was no significant difference between Groups 2 or 3 and Group 1 on both farms, however it is interesting to note that on Farm C, a treatment in May or August with oral triclabendazole resulted in an 8.60 and 9.05 kg advantage, respectively over the producer's normal protocol of giving triclabendazole through a pour-on product. With feeder steer prices currently at 305 c/kg lwt (10/12/2023), this is a loss of nearly $30/head. Also note that on this farm, there was significant drench resistance to triclabendazole (Table 2 (Farm C)), meaning that this impact is likely to be more severe if treatment with oral triclabendazole was compared to an effective drench product.

Table 5: Average weight gain in kg between visit 1 and 6 on farm A and C for the different treatment times (average weight change compared to Group 1)

Farm	Group 2 (May treatment)	Group 3 (August treatment)
A	128 (- 1.66)	131 (+ 1.94)
C	144 (+ 9.05)	144 (+ 8.60)

Table 6: Average daily gain (kg) of each group between visits on Farm A

	Visit 1 & 2	Visit 2 & 3	Visit 3 & 4	Visit 4 & 5	Visit 5 & 6	Visit 1 & 6
Group 1	0.28	**0.26**	0.31	**0.08[a]**	1.44	**0.61**
Group 2	0.26	**0.28**	0.17	**0.24**	1.43	**0.63**
Group 3	0.28	**0.18**	0.30	**0.41[b]**	1.37	**0.65**

On Farm A, there was little drench resistance present and low egg counts (Table 2). However, there were interesting results which are shaded grey in Table 6. Following visit 2 (between visit 2 and 3), which was when Group 1 was treated with nitroxynil/clorsulon and Group 2 was treated with oral triclabendazole, there was about a 100g/day weight gain difference between these two groups and Group 3, which was untreated at this stage. Additionally, following visit 4 (between visit 4 and 5), Group 3, which was treated at visit 4, had a significantly greater average daily weight gain compared to Group 1 (330 g/day greater), and had on average gained 170 g/day more than Group 2. However, despite the difference in average daily gain following each of the May and August treatment, there was no significant difference in average daily gain between the three groups at the end of the trial, indicating that potentially there was some compensatory growth occurring in the weaners.

The PDS is halfway through with another 12 months left. During the next 12 months, four more drench resistance trials will be conducted and the comparison of time of treatment trail will be set up again on Farms A to C in the next cohort of weaners, however this time an effective drench product will be used on each of these farms.

If you would like more information about the PDS or liver fluke, or would like to be involved, please contact Leah Tyrell on 0417 038 758 or email ldtyrell@unimelb.edu.au

Key points:

- ***Fluke is present where we would expect, however there were some locations, which would be ideal for fluke, where none could be found on egg counts***
- ***It's important to understand the lifecycle so you can strategically control liver fluke by knowing when to drench and what products to use***
- ***Drench resistance is present to triclabendazole on a number of farms so beware, particularly if you have used this product lots in the past – monitor!***
- ***Pour on triclabendazole is not as effective as oral***
- ***Fluke infection in weaner cattle is impacting weight gain, even when fluke egg counts are low***

7.7 Appendix 7

7.7.1 Agriculture Victoria - Newsflash

Beef News (In Newsflash, Beef and Sheep Networks – 31st October 2025)

Liver fluke PDS

Liver fluke is a parasitic disease in cattle caused by *Fasciola hepatica*. It affects the liver and bile ducts, leading to poor weight gain, lower milk production, and liver damage.

Cattle typically become infected by ingesting larvae from contaminated grass or water. Controlling liver fluke involves pasture management, using flukicides, and restricting cattle access to wet, marshy areas.

Leah Tyrell from the Mackinnon Project at the University of Melbourne has been leading a Producer Demonstration Site (PDS) funded by Meat & Livestock Australia, in northeast Victoria, known as 'Optimising Liver Fluke Management in Cattle.'

Triclabendazole is a commonly used flukicide. However, resistance to Triclabendazole was found on all 8 farms involved in the study, an unexpected result on 6 of those farms.

Without this trial, producers would likely have continued using a less effective product, unknowingly increasing their production costs. This finding suggests that Triclabendazole resistance may be more widespread than previously thought.

The on-farm demonstrations have been completed, and final data is currently being processed and analysed.

One interesting result came from a farm that compared treatment timing in weaners. They found a 13kg weight advantage in calves treated in late May compared to early May. This showed that delaying treatment slightly helped reduce fluke burden on paddocks and improved weight gain, a win for that farmer.

On another farm, where fluke levels were low, there was no difference between treated and untreated weaners.

This is a valuable finding too, as it shows that monitoring liver fluke through egg counts can help guide targeted, cost-effective treatment, rather than routine drenching.

For more information, speak with your local veterinarian.

7.8 Appendix 8

7.8.1 Producer case study

Optimising Liver Fluke Management in Cattle

Producer case study: Drench resistance and timing of pre-winter drench

For property manager Owen Smith, identifying severe drench resistance to Triclabendazole, and the importance of timing of the pre-winter drench in weaners on the property he manages at Koetong in northeast Victoria, was something he did not expect as a result of being involved in the MLA-supported Producer Demonstration Site (PDS).

Background

Resistance to Triclabendazole, an anthelmintic which has been used to control liver fluke since the 1980s in both sheep and cattle, is not a new concept, with resistance been shown on cattle farms in Victoria in the 1990s. However, without testing for resistance through a drench resistance trial, it is difficult to know if drench resistance is present on farm and the impact this could be having.

Liver fluke in beef cattle is associated with production losses such as reduced growth rates and can affect all ages of cattle. It also costs the industry through reduced value for offal with liver condemnation. The effects of liver fluke are not always obvious, with reduced growth rates only identified if producers are weighing regularly and understand what growth rates are expected.

Findings from the PDS

The PDS comprised of two components, a drench resistance trial, and a treatment comparison trial, which looked at the production effects as a result of the timing of the pre-winter drench.

In the first year, severe drench resistance was identified on the farm Owen manages, with the treatment comparison trial having to be terminated due to the impact of liver fluke was having on the growth rates and welfare of the young stock. These stock were then treated with Nitroxynil/clorsulon, a drench known to be effective against liver fluke.

In addition, at the time drench resistance was identified, adult cows, which had been drenched with Triclabendazole, where in transit from the farm at Koetong to another farm managed by Owen. The cows were drenched with Nitroxynil/clorsulon as soon as they were unloaded for fear of introducing Triclabendazole resistant liver fluke on to this property.

Without the information generated from the drench resistance trial as part of this PDS, continued production effects on young stock and introduction of drench resistance fluke onto another property may have occurred.

In the second year of the PDS, the results from the treatment comparison trial indicated that there may be production impacts on young stock over winter and early spring as a result of incorrect timing of the pre-winter drench.

The trial compared the growth rates of three different treatment groups.

Group 1 – Owen's normal protocol, drench in mid-April

Group 2 – Drench end of May

Group 3 – Drench end of June

The results showed that Group 2 had a 13 kg advantage over Group 1, and Group 3 had a 10 kg advantage over Group 1 by the end of October.

Owen's comment regarding the results of the treatment comparison trial were we "need to look at it more closely, but perhaps we could tweak the drench timing in autumn."

Conclusion

Drench resistance and the production effects of liver fluke often go unnoticed by producers unless they are regularly weighing stock and have knowledge of what stock are capable of gaining. This PDS highlighted the importance of **knowing what drenches work** on your property through drench resistance testing, and the **importance of correct timing** of the pre-winter drench.

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7.9 Appendix 9

7.9.1 Pre project focus group notes

Three focus group discussion dates:

Upper Murray Beef Group – 19th of October 2022

Kiewa Valley Beef Group – 15th of November 2022

Omeo Beef Group – 1st of December 2022

Focus group questions:

1. **What are your thoughts on liver fluke in your enterprise?**
    a. Do you know if liver fluke is on your property?
        i. How do you know if it is/isn't there?

Most of the producers from the three focus groups indicated that liver fluke was present on their farm. When asked how they knew, the responses varied from faecal eggs counts, cattle showing clinical signs and the perfect environment, eg. slow moving water ways. I also felt that through discussion, some of the producers who weren't sure if it was present on their farm, however treated or assumed it was present because of the environment and through conversations with producers in the area who had problems with liver fluke.

- Environment (slow moving water)
- Rainfall >600 mm/annum
- Abattoir feedback
- Faecal egg counts
- Faecal antigen

    b. Could you tell me if there is an impact on production on your farm and give me an example?

Some producers spoke about reduced growth rates, with a discussion about bottle jaw but not actually the impact on production.

- Reduced weight gain
- Fertility issues
- Weight loss
- Deaths

    c. What do you understand about the liver fluke life cycle?

Most producers agreed that the lifecycle of liver fluke was difficult to understand. They knew that the lifecycle required a snail and that it needed water. However, when quizzed about the source of moisture, producers thought that the snail could be found in troughs and stagnant water rather than slow moving water ways.

- Liver fluke larvae need a snail to complete the lifecycle
- Both the snail and liver fluke larvae needs moisture
- Both snail and larvae are inactive over wnter

i. When does the greatest infective larval pick up occur in cattle and why is this important?

Generally, there was little knowledge about when the greatest larval pick up was. Some producers knew that late spring and autumn were the greatest time for pick up. A lot of producers agreed that it was important to know time of greatest pick up so that they could time drenching, despite this not being the main reason to understand the greatest larval pick-up time.

- No activity of snail or liver fluke over winter = no infective larval pick up
- Greatest infective larval pick up in from end of spring through to end of autumn
- Impacts strategic drenching

2. **How do you manage liver fluke?**
    a. When do you drench and what with?
        i. Why at this time of the year?
        ii. Why with this product?

Lots of producers discussed that they drench in the months starting with 'A', April and August or give a drench after the first frost. Generally, they did not understand why they were treating at this time of the year or that they are targeting different stages of the lifecycle at the different times of the year and therefore needed to use a different drench group at the different time of the year.

- Strategic drenching
- Grazing management
- Monitoring
- Assessing participants understanding of strategic drenching and different products available

    b. Do you graze paddocks differently?
        i. Why?

No one grazed paddocks differently due to liver fluke. There were lots of comments that this is not possible because lots of paddocks have areas that are 'flukey' environments

- Don't graze young stock in known "flukey" paddocks

    c. Do you fence off "flukey areas?

Similar response to question 2b. They would have too many areas fenced off.

    d. Do you monitor for fluke infections in your cattle?

Some of the producers were conducting fluke egg counts on their cattle, however they were mostly just getting qualitative tests done which indicate the presence or absence of fluke eggs in the faeces, rather than quantitative tests which give number of eggs per gram of faeces. Additionally, producers just drenched regardless of knowing if fluke was present or they thought about drenching for fluke once cattle had visual signs of infection, eg. bottle jaw

- Different tests available and which one to use
- Understanding of the benefits of monitoring and utilising this with strategic management

    e. Do you know if there is drench resistance present to fluke drenches on your farm?
        i. Have you tested before?

Most of the producers had no idea if drench resistance was present and I felt like it was a new concept to a lot of producers at the focus groups. There were a couple of producers who thought it may be present but hadn't had it tested.

f. Costs?
    i. Do you know what liver fluke is costing you?

Producers thought that liver fluke was probably costing them something but had no idea if it was.

- Prevention costs? (drenches)
- Do you think liver fluke is having an impact on weight gain/fertility and what this might be?

    i. Do you know your cost of production?

3. **Why do you feel satisfied/unsatisfied with your management of liver fluke?**
    a. Are you confident that you are managing liver fluke well on your farm?
        i. Are you confident liver fluke would be an issue if you didn't manage it?
        ii. Are you confident you are drenching at the correct times?
        iii. Are you confident you are using the correct and effective drench product?
    b. Drenching but not getting the expected results?
- Not achieving expected weight gains/fertility rates in young stock
- Still getting + liver fluke abattoir feedback
    c. Overall are you happy with the way you manage liver fluke on your property?
    d. Are you considering making changes to the way you manage liver fluke on your property?
    e. How likely are you to make changes?
- Unsure, Very unlikely, Unlikely, Possible, Likely, Very likely

Generally, producers felt they could improve their management of liver fluke on their farm. They felt like they were following recommendations for treating liver fluke but didn't understand the impact fluke was having on their farm but felt if they didn't treat it would have an impact. They also felt that understanding the liver fluke lifecycle was difficult and made it harder to manage hence why follow the saying 'drench in the months starting with A' or 'drench after the first frost'.