

# final report

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Prepared by: Deb Maxwell  
University of New England  
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## **PDS: New England Wormboss**

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## **Abstract**

This project sought to demonstrate the efficacy and financial benefits from implementing the WormBoss worm control program to sheep producers in the New England region and more broadly in the high summer rainfall areas.

This project commenced with 13 core participants with 7 of them continuing throughout. Worm control is known to be complex and core producers have found some practices challenging, especially in the drought that prevailed over much of this project. Drench Tests were found to be especially valuable resulting in changed drenching decisions. The trials also showed the value of testing single actives to calculate efficacy of combination drenches. Regular worm testing was also used.

Over the course of the demonstration project, six (6) workshops were held with 235 producers attending covering 148 individuals/businesses. As a result of the project most producer attendees intend to implement the practices demonstrated, if they are not already doing them. Webinars that summarise the workshops have also been produced.

## **Executive summary**

### **Project objectives**

Productivity losses and welfare implications from gastro-intestinal worm infection in sheep demand a continued effort to improve producer management of this disease.

The project assisted a group of core producers to implement the WormBoss program in the New England region and to be an example to other producers, supported by workshops, webinars and other communications materials, to extend the results and encourage wider adoption by industry.

### **Significant results**

- Core producers showed a very high intention to carry on implementing the WormBoss program, even though they encountered difficulties in implementation.
- Likewise, pre-and post-workshop surveys showed a high intent from observers to implement the practices that they heard about and saw.
- Analysis of DrenchTest results indicated that the recommendation for producers to test efficacy of single actives and then calculate efficacy of multi-actives is sound and should be continued.
- Six WormBoss workshops were held with 235 producers attending covering 148 individuals/businesses. The confidence of attendees increased from 5.8/10 to 7.2/10 as a result of workshop attendance. Their knowledge improved from 4.3/10 to 7.9/10.
- Five WormBoss webinars were produced with four being delivered to date and 472 attendees.
- Five case studies were produced and published.

Immediate benefits were gained by the core producers and the direct observers, but the materials produced, and the considerable insights gained about adoption, will continue to be used and value-added by ParaBoss to assist in the promotion of the WormBoss practices to industry.

### **Conclusions and recommendations**

This project highlights the continuing need to address the low adoption of worm control practices, but particularly, drench resistance tests as well as grazing management.

Funders should seriously consider all options to make drench resistance testing easier to adopt, which includes alternatives to the FECRT process.

Strong support of ParaBoss, which has assumed most communication and extension effort for parasite control Australia-wide should continue.

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## 1 Background

Gastrointestinal worms, in particular barber's pole worms, are the number one animal health issue for sheep producers in the NSW New England region (as well as in other high summer rainfall areas of Australia). In this area, sheep deaths are a significant feature of Haemonchus on many farms, which is not only a significant production issue, but an animal welfare problem.

Gareth Kelly (unpublished 2011) found that the annual cost of worms to a self-replacing Merino enterprise under typical management in the summer high rainfall zone where barber's pole worm predominates (i.e. New England) was \$11.09/ewe, but that producers who adopted the WormBoss worm control program reduced this cost to \$5.80/ewe. Much of these savings were achieved by a reduction in deaths due to worms (on the typically managed farms there were 6% deaths directly attributable to worms, but only 1% deaths from worms on the farms implementing the Worm Boss program).

WormBoss is part of ParaBoss which is funded by Meat and Livestock Australia and Australian Wool Innovation and coordinated by the University of New England with industry oversight.

This project sought to further establish WormBoss as an important tool to manage worms in high-risk areas and improve productivity and animal welfare.

## 2 Project objectives

The initial objectives of the project were that by June 2019:

1. 30 producers in the New England area will have implemented the WormBoss program and obtained the following expected benefits:
  - a. Deaths of Merino ewes and lambs from worms decreased by at least 50%.
  - b. Production loss from worms decreased by at least 20%
  - c. Labour requirements for worm control are reduced by up to 30%.
  - d. Cost of worms (combined for expenditure and production losses) decreased by \$4/head for Merinos and \$2/head for crossbreds and non-Merinos.
2. A series of activities will have been implemented to increase the skills and confidence of the 30 core- producers and up to 100 other producers in the area to know how and when to correctly:
  - a. Purchase worm-resistant rams;
  - b. Undertake a drench resistance test and drench checks;
  - c. Undertake routine worm tests;
  - d. Prepare low worm risk paddocks for lambing ewes and weaners;
  - e. Move stock to a spelled paddock in a rotational grazing system;
  - f. Make sound drenching decisions based on their Drench Test results, worm egg count results and the time of year, class of sheep etc.
3. A comprehensive communication program will have been conducted on project findings
4. So that a further 200 or more producers in the New England region and 1000 or more other producers throughout Australia will be influenced to implement the WormBoss program.
5. Additional data will be collected to demonstrate the value of conducting drench tests solely with single actives and using their results to calculate efficacy for all combination drenches.

However, after a year of progress objective 1 was modified to:

1. 10 producers in the New England area will have implemented the WormBoss program and would provide extensive feedback on the application of the program in their system.

### 3 Methodology

#### 3.1 Overall methodology

There were key activities repeated 3 times in a year for 3 years (though exact activities at workshops will vary with time of year):

- Promotion of the next workshop via local and regional media and networks (targeting regional sheep producers and their advisers [particularly rural merchandisers])
- Workshops where the WormBoss program will be briefly covered in full, but the pertinent management activities for the coming 4 months are explained and demonstrated in detail, and results and experiences from the core participants are described and discussed. Anyone could attend these workshops (including producers from other regions, as the principles apply elsewhere). The core participants provide a focus for demonstrating implementation and results.
- Assist core participants by explaining program requirements at meetings or between.
- Communication to attendees (1 or 2 emails [or post]) between each meeting to remind them of current activities and what to do, when to do it and how to find more information.
- Communication to other sheep producers in the region and nationally, describing the project, what is being achieved, who is involved, elements of case studies, and season-relevant technical information (e.g. preparing low worm-risk paddocks.) Distribution by local, regional and national media, ParaBoss (News, Facebook and website), MLA Feedback/Friday feedback and other mechanisms (e.g. through local Landcare groups). Video on Landline/Digital Farm TV if possible.

#### 3.2 On-farm trial methodology

Core participants fully implemented the WormBoss program in one paddock/mob, but continued with one other paddock/mob being managed using their previous management. Activities were conducted as follows.

**Table 1 On-farm practices to be implemented by core producers**

Dates (month end)	Activities
February 2016	Identify 2 lambing paddocks.
	Allocate these as
	W: WormBoss management
	T: Typical management
February- September 2016	Prepare lambing paddocks:
	W paddock as per the WormBoss program
	T paddock using management typically used in the last few years.
July 2016	Carry out a Drench Resistance Test.
August 2016	Identify ewe mobs to go into the lambing paddocks, monitor and treat up to lambing as required.

September 2016	At lambing time, drench ewes into lambing paddocks:
	W: short-acting treatment shown to be effective by the DrenchTest.
	T: short-acting treatment typically used in last few years.
September 2016 - March 2017	Between lambing and weaning, ewes and their lambs will continue to graze the allocated paddocks.
	WormTests (WECs) will be carried out on the ewes and lambs in each paddock:
	Pre-lamb marking
	Mid-way between lamb marking and weaning
	Pre-weaning (for ewes)
February 2016-May 2017	Ewes and lambs will be drenched as required based on the results from their WEC Tests.
August 2016- February 2017	Participants will prepare 2 weaning paddocks.
	W: WormBoss management.
	T: Typical management with a short acting treatment.
February 2017	At weaning the lambs using the W and T lambing paddocks will progress to these corresponding weaning paddocks and be treated as follows.
	W: short-acting treatment shown to be effective by the DrenchTest.
	T: short-acting treatment typically used in last few years.
February 2017 - May 2017	WormTests (WEC) will be carried out on the lambs in each paddock:
	W: At 4-week intervals until treatment is required.
	T: At 4-week intervals until treatment is required.
February, June, October 2016	Participants will review and discuss their progress/results at the ongoing workshops.
	Participants will also be guided on using WECS and the Drench Decision Guides to make drenching decisions.
October 2016	Participants will be shown how and encouraged to purchase worm resistant rams
December 2016	Participants will be assisted in planning for next year's paddock preparation.

Note: The same procedure was carried out from 2017 with a different set of core participants.

During the trial period the following was to be recorded in the W and T mobs:

- Deaths
- Times when clinical signs of worms are evident
- Drenches used and their cost
- Labour (time spent drenching and testing)
- Worm Egg Counts

#### **WormBoss implementation by core producers**

The intent was to recruit 30 producers for a year of involvement each—approximately 10 in each of the 3 project years. Due to poor recruitment in the second year it was decided to continue with the original participants from year one over the three years, although another was recruited in the second year, and another in the third year.



As noted above, the core producers were asked to fully implement the WormBoss program in one paddock/mob, but continue with one another paddock/mob being managed using their previous management. They were also asked to maintain comprehensive records of sheep numbers, deaths, time spent on activities, drench use and worm egg counts.

Each producer was asked to:

- Conduct a comprehensive Drench Resistance Tests, following the WormBoss guidelines: <http://www.wormboss.com.au/tests-tools/tests/testing-drench-effectiveness-with-a-drenchtest.php>
- Prepare and use low worm-risk lambing paddock and weaning paddock according to WormBoss recommendations. (<http://www.wormboss.com.au/programs/sheep/tablelands-slopes/grazing-management.php>)
- Operate a control lambing paddock and weaning paddock for comparison
- Maintain records of sheep using these paddocks that covered sheep numbers, deaths, drenching history and worm egg counts. A casual assistant was also employed to remind the co-operators and help record their data.
- Regularly WormTests the sheep that were to use the WormBoss and control paddocks. (<http://www.wormboss.com.au/programs/sheep/tablelands-slopes/when-to-wormtest-and-when-to-drench.php>)
- Apply the recommended practices to manage drench resistance. (<http://www.wormboss.com.au/programs/sheep/tablelands-slopes/managing-drench-resistance.php>)
- Where possible use worm resistant sires for breeding.

The project supplied all the items required for the Drench Resistance Test and paid approximately half the costs of the laboratory worm egg count testing: \$400 out of \$770 total cost. The project also paid for about half of the monitoring worm egg count tests.

The principal investigator assisted core participants by explaining program requirements at meetings or between, and also provided personal worm management advice whenever requested by the core producers.

Collecting data for an economic analysis was changed to collecting quantitative feedback and insights into implementation of the WormBoss program.

## 4 Results

### 4.1 Year 1

Thirteen core producers initially said they would participate, nine subsequently commenced participation with a Drench Resistance Test.

Three workshops were conducted in 2016

- February 15, Mannum Park, Guyra
- July 14, Harwalk Park, Guyra
- November 15, Europambela Walcha

## 4.2 Year 2

Eight existing core producers and one new producer continued to implement the program and provide feedback to ParaBoss.

Two workshops were conducted in 2017

- February 14, Warrane, Armidale
- November 1, Kurrajong, Deepwater

Report on Calculating efficacy of multi-actives versus actual testing (provided below).

## 4.3 Year 3

Seven existing core producers and one new producer continued to implement the program and provide feedback to ParaBoss

One workshop was conducted in 2018

- February 22, Ashford Bowling Club

Spreadsheet were provided to MLA with all the data recorded from observers and participants at the workshops.

Exit interview report: Perceptions were captured on the value and ease of adoption of the WormBoss program (provided below).

## 4.4 Final results

### 4.4.1 Perceptions on the value and ease of adoption of the WormBoss program

Exit interviews were conducted with eight core producers. Their qualitative responses indicate overall their perceptions, successes and difficulties they had implementing the WormBoss practices.

#### Lambing Paddock Preparation

Core producers believed that preparing a low worm-risk paddock should:

- a) Decrease the number of drenches needed during the lambing to weaning period (all respondents).
- b) Decrease the number of drenches needed during the rest of the year (majority of respondents).
- c) Possibly decrease the number of long acting drenches needed (60% respondents currently using LA products).
- d) There was no consensus on whether cost of drenches would increase/decrease (50% of respondents believed that drench costs would increase due to the use of more expensive drench products).
- e) Possibly increase the number of worm tests required in the lambing to weaning period (50% of respondents).
- f) Decrease the number of (and/or how often) sheep are seen with visible signs of worms or with very high worm egg counts (all respondents).

- g) Increase their confidence of getting from lambing to weaning without severe illness or deaths from worms (all respondents).

The majority of the core producers had attempted to prepare low worm-risk lambing paddocks in the years 2016-2018. Just under half of respondents found it fairly easy in practice to achieve this, however the balance found it very difficult. All core producers felt that they had at least some degree of success in achieving their goal of preparing low worm-risk paddocks, however frequency of success varied.

A number of difficulties were identified in preparing low worm-risk lambing paddocks. Common issues included the fact that sheep got into paddocks accidentally, sheep had to be intentionally run in prepared paddocks due to feed deficiencies elsewhere or not enough available paddocks. In some instances, the sheep in the paddocks being prepared turned out to be wormy due to the use of less than fully effective drenches. The placement of wormy sheep in such paddocks whilst the weather was warmer than expected was also an issue identified.

All core producers found it easier to prepare low worm-risk paddocks in some years/paddocks than others, principally due to seasonal conditions and feed availability. Half of the respondents believed that they were getting better at managing those difficulties and succeeding more often.

For the times when the core producers felt that they had successfully implemented the preparation process, the following results were achieved:

- a) All respondents used less drenches during the lambing to weaning period.
- b) Approximately half of respondents administered less drench during the rest of the year.
- c) There was no discernible change in the number of long acting drenches needed.
- d) Variable responses were given as to the change in the cost of drenches used.
- e) Worm testing either stayed constant or increased in the lambing to weaning period.
- f) All respondents stated that the number of (and/or how often) sheep were seen with visible signs of worms or with very high worm egg counts decreased.
- g) The majority of respondents had increased confidence that they can get from lambing to weaning without severe illness or deaths from worms.

The majority of core producers (7/8) intend to prepare low worm-risk paddocks in coming years, but to varying proportions of the ewe flock (10%-100%).

### **Weaning Paddock Preparation**

Core producers believed that preparing a low worm-risk paddock should:

- a) Decrease the number of drenches needed during the three months after weaning (all respondents).
- b) Decrease the number of drenches needed during the rest of the year (majority of respondents).
- c) There was no consensus on whether the number of long acting drenches needed would change.
- d) There was no consensus on whether cost of drenches would increase/decrease.
- e) There was no consensus on whether the number of worm tests required in the three months after weaning would change.
- f) Decrease the number of (and/or how often) sheep are seen with visible signs of worms or with very high worm egg counts (all respondents).

- g) Increase their confidence of getting three months after weaning without severe illness or deaths from worms (majority of respondents).

Over half of the core producers had attempted to prepare low worm-risk weaning paddocks in the years 2016-2018. The majority of respondents found it fairly easy in practice to achieve this. All core producers felt that they had at least some degree of success in achieving their goal of preparing low worm-risk paddocks, however frequency of success varied.

A number of difficulties were identified in preparing low worm-risk weaning paddocks. Common issues included the fact that sheep got into paddocks accidentally, sheep had to be intentionally run in prepared paddocks due to feed deficiencies elsewhere or not enough available paddocks or sufficient cattle to utilise feed. The need to fully utilise crops grown in weaning paddocks was also an issue identified.

All core producers found it easier to prepare low worm-risk paddocks in some years/paddocks than others, principally due to seasonal conditions and feed availability. Nearly all of the respondents believed that they were getting better at managing those difficulties and succeeding more often.

For the times when the core producers felt that they had successfully implemented the preparation process, the following results were achieved:

- a) All respondents used less drenches during the lambing to weaning period.
- b) The majority of respondents administered less drench during the rest of the year.
- c) The majority of respondents did not use long acting drenches in this scenario.
- d) The majority of respondents identified no change in the cost of drenches used.
- e) Worm testing either stayed constant or increased in the three months after weaning.
- f) The majority of respondents stated that the number of (and/or how often) sheep were seen with visible signs of worms or with very high worm egg counts decreased.
- g) All respondents had increased confidence that they can get three months after weaning without severe illness or deaths from worms.

All of the core producers intend to prepare low worm-risk paddocks in coming years, the majority for the entire weaner flock.

### **Worm Egg Count testing**

Over half of core producers claim to always use WEC to monitor worm burdens as the basis for drench decision making. The majority of respondents use WEC's to at least some degree for this purpose. Samples are most commonly processed at laboratories, however some respondents (25%) perform the majority of their testing on-farm.

Commonly identified impediments to worm testing include the time required to collect and prepare samples, forgetting or just not getting around to it, and to a lesser extent cost and logistics of getting samples sent/delivered to laboratory on time.

The most typical difficulty encountered when collecting and preparing samples for worm egg counts is the lack of dung deposited by sheep, particularly lambs. In respect to obtaining and utilising the results, the delay in receiving them is sometimes problematic, as is the interpretation of them. Worm egg counts on individual mobs are typically performed routinely by respondents, often drenching is not required.

## **Drench Tests**

All core producers had conducted drench tests and indicated that a drench resistance test was both very useful and very/fairly easy to conduct. Less than half of respondents (3/8) had conducted prior comprehensive drench resistance tests. Those producers who had not done so indicated that this was due to the fact that they had not seen the value of it (most commonly), along with the difficulty in organising or lack of “know how”. Nearly all respondents (7/8) claimed that they would commit to performing another Drench Resistance Test in 2-3 years.

## **Drench/ BarberVax**

The majority of core producers used WEC to decide when sheep should be drenched (except for routine drench times such as lambing/weaning). Some respondents used observation of animals (in particular, eye membrane colour and evidence of “tail” in the mob) in conjunction with WEC (or instead of). Over half of respondents (5/8) had regularly used the Drench Decision Guide.

Since conducting the Drench Resistance Test, the majority (7/8) of core producers often (or always) choose a greater than 98% effective drench based on their Drench Test results. All respondents often (or always) choose a combination drench (or undertake concurrent drenching). 50% of core producers use long-acting (LA) drench products, most typically for preparation of low worm-risk paddocks in autumn. Other reasons cited include to provide worm protection over high risk periods and as a routine weaner treatment in early March. An effective primer is typically used with long-acting drench products, whilst an effective exit drench is claimed to be administered by half of LA users in this survey. The majority of such producers indicate that they have (or will) test the persistence of the long-acting product.

The majority of core producers often (or always) try to rotate the drench actives used and likewise do not allow price to deter them from selecting the ideal drench for the job.

Over half (5/8) core producers currently use BarberVax vaccine. The reasons cited for using it include having a lot of problems with Barber’s Pole Worm, having too few effective drenches and trying to preserve the effectiveness of such drenches. All respondent users considered BarberVax to be at least somewhat useful (3/5 very/quite useful) and over half of these producers are committed to continued use of the vaccine program.

## **Breeding**

The majority of core producers purchased rams in the last 12 months from a source that provided WEC ASBV’s. 80% (4/5) of this cohort chose at least some of their ram purchases based on them being more worm resistant than others on offer. A negative WEC ASBV was the key criteria for this trait. When WEC ASBV’s were available at purchase but were not used in the selection process the two reasons given were that other traits were considered more important and that breeders were not retained in the flock.

The minority of producers who source rams where WEC ASBV’s are not available would typically not look to change ram breeder as they were otherwise happy with this ram source.

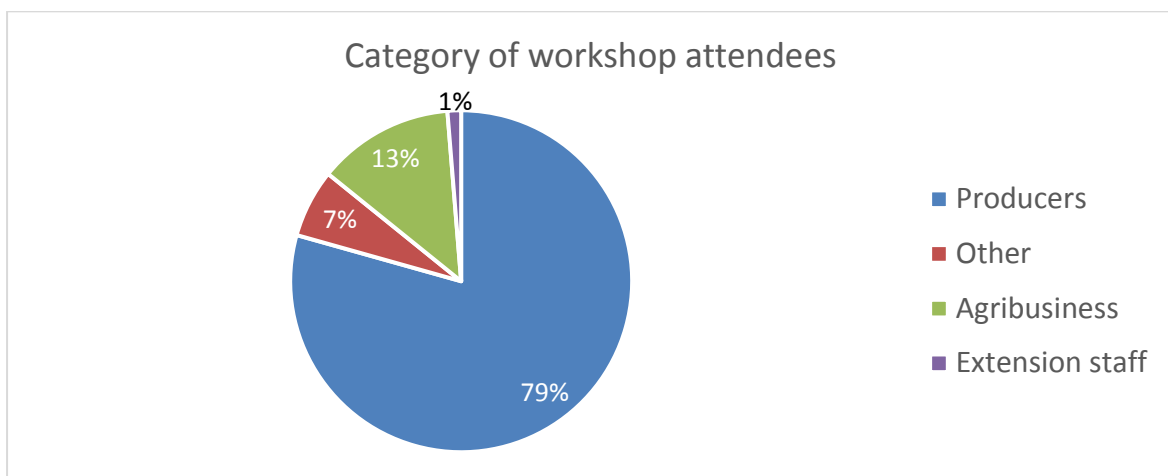
## **Confidence of producers**

After completing the WormBoss project all core producers were moderately/very confident that they can control worms in their sheep. Direct participation in the project was considered quite/very helpful in building their confidence.

#### 4.4.2 Workshops

Six workshops were run. Key data is presented here; a full data set of pre- and post-survey responses can be found in the associated MS Excel file: WormBoss PDS workshop data 28 March 2018, provided to MLA.

There were 173 unique attendees across the 6 workshops—some individuals attended multiple workshops. These were 123 producers, 20 agribusiness staff, 2 extension staff and 10 others (such as WEC laboratory staff).



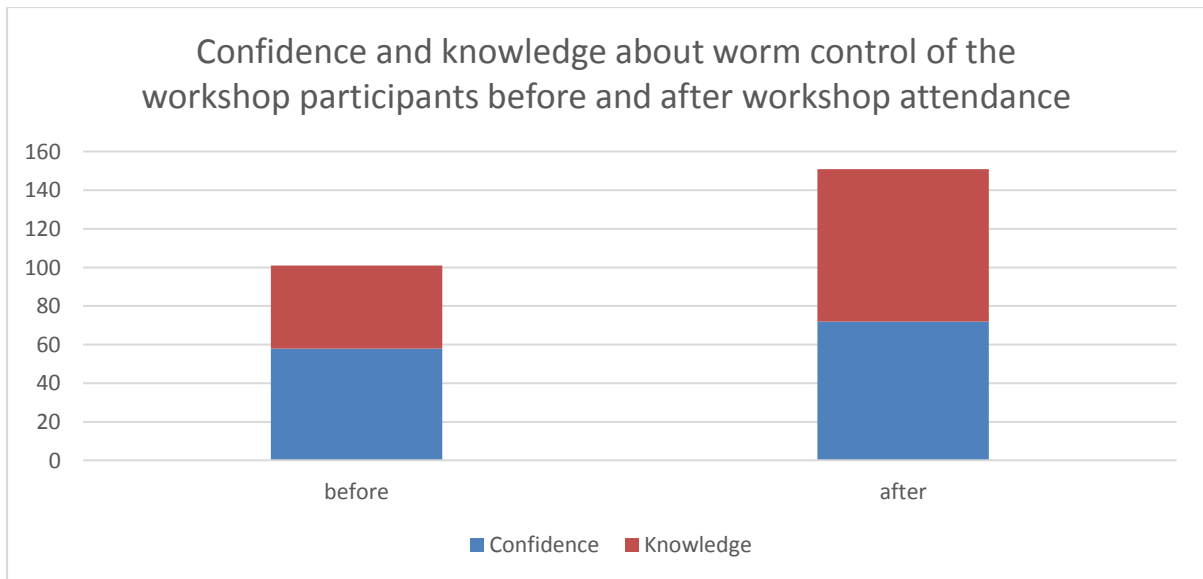
**Figure 1** Category of attendees at the WormBoss workshops.

The producers collectively managed 170,000 hectares and 377,000 sheep and 33,000 cattle.

Attendees were asked to complete pre- and post-workshop surveys to assess the benefits of involvement.

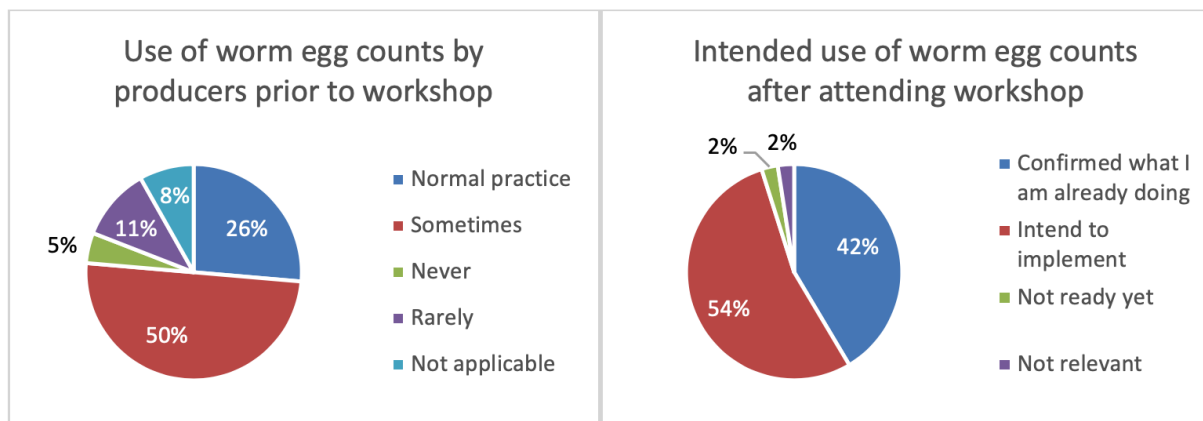
Pre-workshop self-assessed confidence in their worm management skills was 5.7 out of 10. This rose to 7.2 out of 10 after the workshops.

Attendees were asked to complete a technical assessment of their worm control knowledge before and after the workshops. The average attendee score beforehand was 43% correct. After, for the same questions, the average score was 79%.



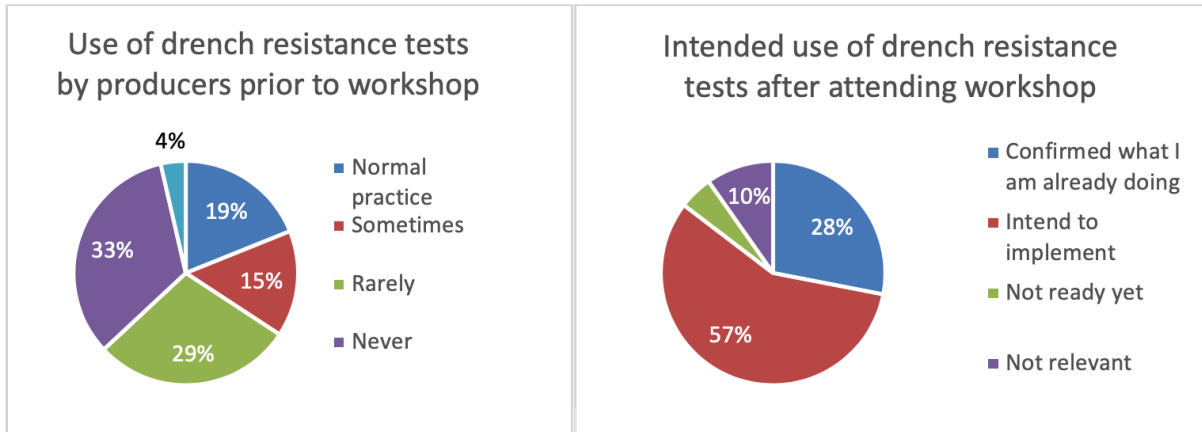
**Figure 2. The change in confidence and knowledge about worm control of the workshop attendees after workshop attendance.**

When producers were asked about the key practice of conducting worm egg counts, only about one quarter of them used them routinely, although half did sometimes. After the workshop the majority of producers either intended to implement them routinely or said it confirmed what they were already doing.



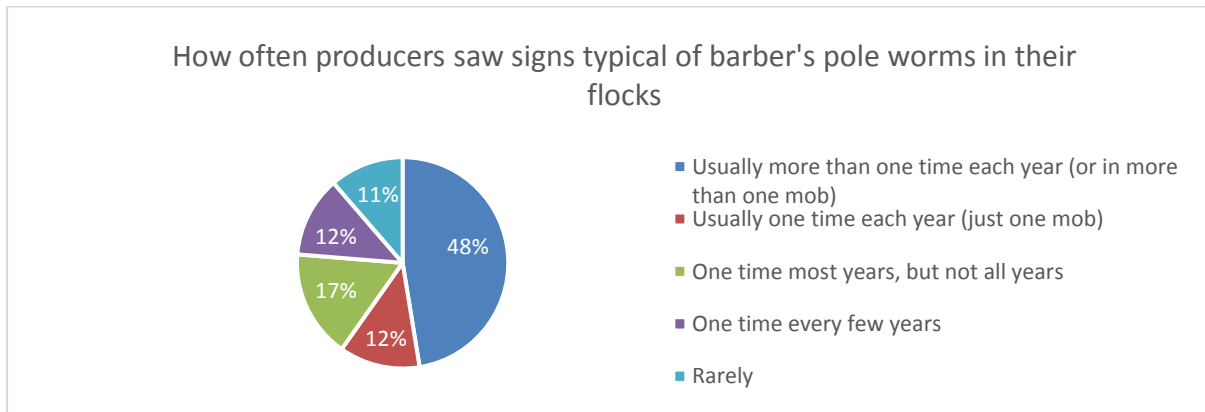
**Figure 3a. Use of worm egg counts by producers prior to workshop, and 3b. Intended use of worm egg counts after attending a workshop.**

When asked about Drench Resistance Tests, including formal Faecal Egg Count Reduction Tests as well as DrenchChecks (WECs before and after drenching a mob), less than 20% used them as normal practice and a further 15% did them sometimes, but after the workshop 85% either intended to implement them routinely or said it confirmed what they were already doing.



**Figure 4a. Use of drench resistance tests by producers prior to workshop, and 4b. Intended use of drench resistance tests after attending a workshop.**

The extent to which producers saw typical signs of barber’s pole worm in their flock was high. For almost half, it was a repeat problem within each year. Another quarter of respondents saw signs of disease every or most years



**Figure 5 Incidence of observation of signs of barber’s pole worms in observer flocks.**

#### 4.4.3 Webinars

Five webinars have been created, with four delivered to date.



Table 2 Webinar titles and usage statistics.

Title	Date delivered	Number of attendees at start	Number of attendees at finish	Number of recording downloads/views*	Number of related questions
<b>WormTests, what's stopping you</b>	28/05/2019	125	87	95	19
<b>Bulk WormTests increase accuracy</b>	9/07/2019	115	97	37	18
<b>Preparing low worm risk paddocks</b>	30/07/2019	50	45	27	8
<b>Drench Resistance Testing</b>	13/08/2019	72	59	-	10
<b>Choosing and using drenches</b>	10/09/2019	-	-	-	-

\*Number of recording downloads in the last 3 months.

At the end of the fourth webinar, the farmer participants were asked to respond to a question: How useful was this webinar to assist you in proceeding with a decision on whether to do a drench resistance test?

Not all participants answered as we specifically asked only farmers to, therefore there was no answer for 29% of attendees. 25% said the webinar was 'extremely useful', 42% said 'very useful', 4% said 'moderately useful'. No respondents chose 'somewhat useful' or 'not useful'.

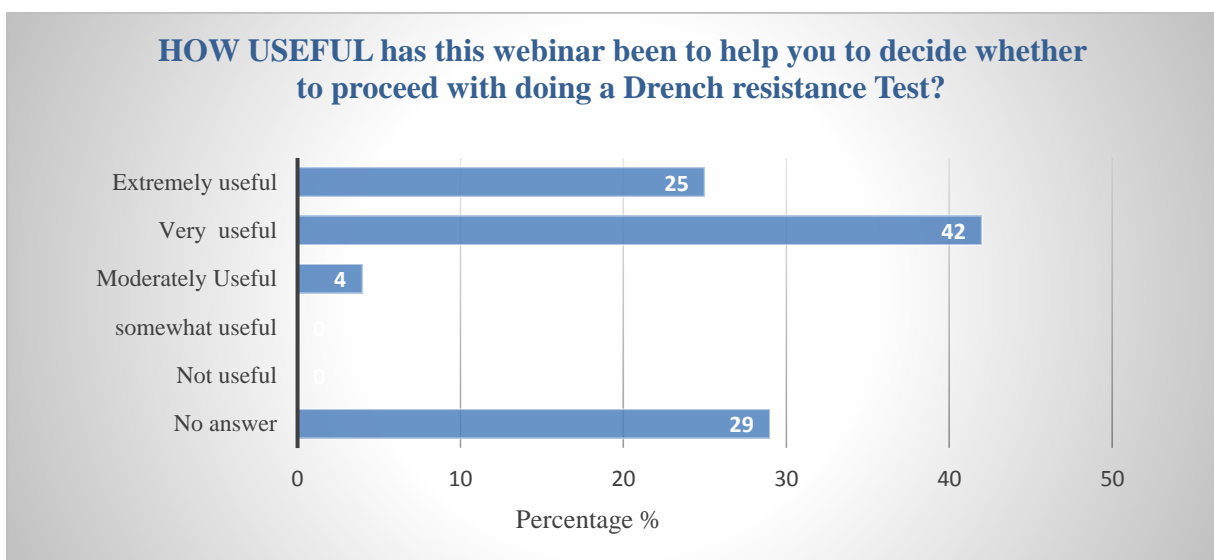


Figure 6 Usefulness of the webinar: Drench resistance testing.

#### 4.4.4 Calculating efficacy of multi-actives versus actual testing

By Lewis Kahn and Deb Maxwell

Conducting drench tests is a laborious and costly process, but yields highly valuable results that enable a manager to choose the most effective drenches for worm control on their property.

Modeling shows that using effective drenches, especially in combinations, are two of the three most effective practices to reduce the rate of development of drench resistance (the third practice is to avoid the use of long-acting drenches).

Effective drenches also provide greater therapeutic benefit, a longer time between drenching and enable smart grazing, the practice of grazing a paddock while the sheep are in the protection period of a drench, during the preparation of a low worm-risk paddock.

There are over 14 different generic combination drenches, so it would be very expensive to test each one. However, there are only 9 individual actives that need testing, and with their results the efficacy of multi-active drenches can be calculated rapidly and easily.

A calculator is found on the WormBoss site that allows anyone to do these calculations.

An activity to review the validity of this method of assessing the efficacy of multi-active products was carried out as part of the New England WormBoss PDS project. Drench Resistance Tests were carried out on 12 cooperator properties during 2016, 2017 and 2018, with a standard set of drenches included. 11 of these also tested the same two multi-actives. One other property tested a different multi-active.

An analysis was carried out by Dr Lewis Kahn to review and compare the results.

The conclusion was that the WormBoss recommendation should remain unchanged, that is:

*Test single active drenches and then use the results to calculate the efficacy or a range of multi-active drenches.*

**Table 3 Summary table of mean efficacy values by property, active and (A=actual; P=predicted -aka calculated).**

	ABA	FEN	LEV	LEV/OX		LEV/OX/ABA	
Property	A	A	A	A	P	A	P
A	64	53	76	88	89	77	96
B	37	43	95	98	97	97	98
C	25	7	73	83	75	92	81
D	90	98	94	97	100	98	100
E	56	33	86	91	91	85	96

F	69	64	96	98	99	98	100
G	78	71	80	100	94	67	99
H	35	34	47	45	65	50	78
I	30	30	77	42	84	53	89
J	54	15	86	67	88	69	94
Overall average	53	44	79	79	87	77	92

**Some anomalies:**

Property G actual efficacy for LEV/OX = 100% but for LEV/OX/ABA = 67%. This doesn't match with efficacy of individual actives.

Property E actual efficacy for LEV/OX = 91% but for LEV/OX/ABA = 85%. This doesn't match with efficacy of individual actives.

But, remember that the lower the efficacy of a single active, the higher will be the variation among animals and the more likely that 10 sheep don't give you an estimate of the true mean. Look at Property F with high LEV efficacy and all is good.

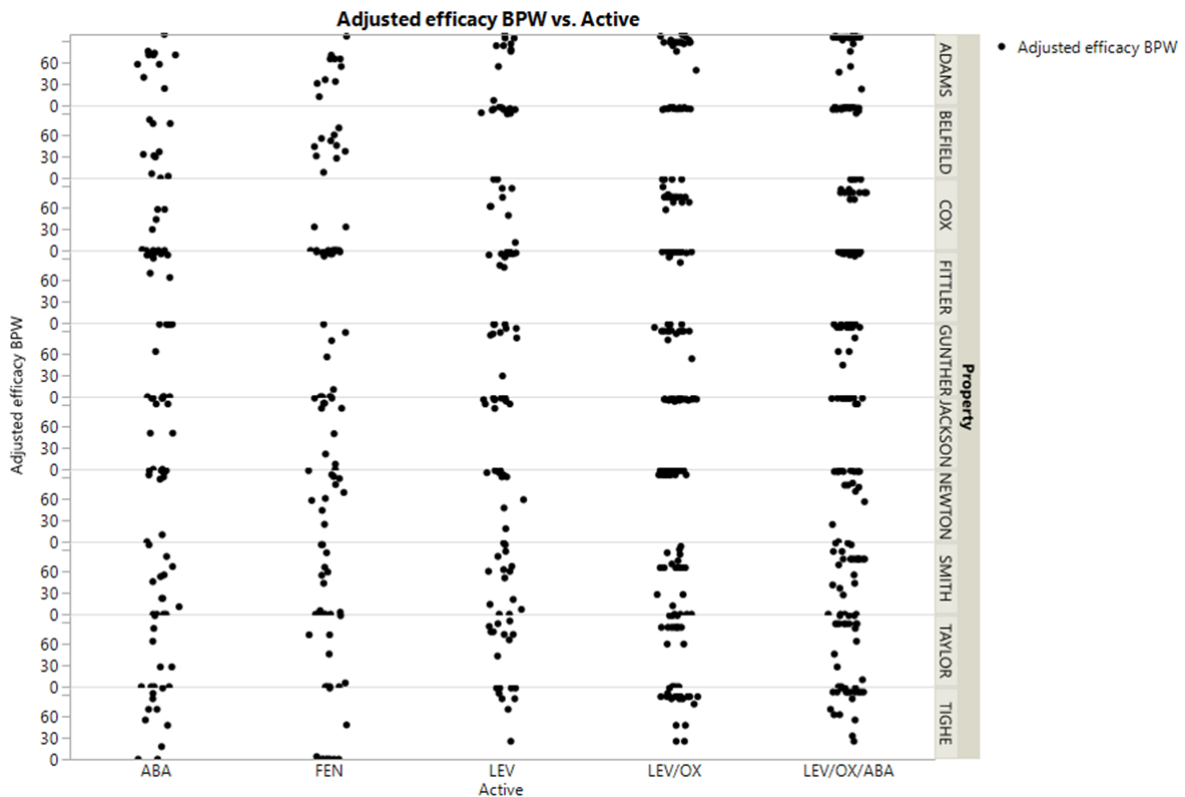


Figure 7 A summary across all farms and actives, displays the variation, which is normal.

**Overall analysis**

Across all farms (A = actual; P = predicted - aka calculated). Actual and predicted values for efficacy against BPW differed significantly  $P=0.0175$ . There was a significant difference between actual and predicted for BZ/LEV efficacy.

**Table 4 Least squares means table**

Level	Least Sq Mean	Std Error	Mean
A	79.132836	2.3371482	79.1328
P	87.047619	2.3371482	87.0476

$P<0.0001$ . There was a significant difference between actual and predicted for BZ/LEV/ML efficacy

**Table 5 Least squares means table**

Level	Least Sq Mean	Std Error	Mean
A	77.222334	2.2036201	77.2223
P	92.280952	2.2036201	92.2810

Referring back to the Table 1:

A and P for LEV/OX differed significantly for Properties B, I and J.

A and P for LEV/OX/ABA differed significantly for Properties A, C, D, G, H, I and J.

Consider Property J. How could LEV/OX/ABA be 69% when the LEV alone is 86%? Which one are you going to trust? I'd trust the one calculated from 3 tests and 30 animals rather than the one from 10 animals.

**Table 6 Comparison of single-active and multi-active efficacy results on one property.**

	ABA	FEN	LEV	LEV/OX		LEV/OX/ABA	
Property J	54	15	86	67	88	69	94

## Conclusion

The relatively small numbers of animals used in typical tests (10–15 sheep) mean that the confidence intervals for the results are large. This is particularly so where the efficacy of a product is low. As such, the true accuracy of the results cannot really be gauged, however, calculating results for multi-actives uses data from more animals, which reduces the confidence intervals. Therefore,

the calculated results are more likely to reflect the true mean than results of actually testing the multi-active.

Consequently, testing single active drenches and then using the results to calculate the efficacy of a range of multi-active drenches, is still recommended.

## 5 Discussion

### 5.1 Key Findings

#### 5.1.1 Core participants and implementation of program

The methodology of the project was changed in a number of ways as a result of feedback and responses from core participants.

- Number and time of participation
- Data to be provided.

Initially three lots of ten core participants were to be involved for one year each, however, we were unable to recruit enough new participants in the second year. The decision was made to continue with existing participants, which was a better choice, in hindsight.

The on-farm practices do have complexities to them and these need to be modified in line with seasonal variations. Therefore, continuing with the same participants enabled them to learn as they went and relate their experiences as they gained more practice under different seasonal conditions.

Economic results were intended to be calculated but all participants struggled to provide the necessary data to enable this. In numerous cases more sheep came out of a paddock than went in due to straying or miscounting, making it impossible to calculate losses.

It was hoped that obvious differences in worm egg counts between control and WormBoss paddocks would be apparent, but this was often not the case and on discussion with core producers it was evident they mis-recorded and made operational mistakes, but also the differences between WormBoss and Control paddocks and WormBoss and Control sheep seriously confounded the results. For example, using crossbred ewes as a control group versus Merino sheep in the WormBoss group introduces considerable bias as the heavier crossbreds almost always have better resistance to worms than Merinos. Also, some paddocks had a worse worm contamination history than others. Unfortunately, most operators did not have enough mobs and similar enough paddocks to provide a fair, even comparison.

The seasonal conditions provided a major challenge and confounded results. The first year, 2016, had a very dry autumn, which in effect, prepared even the control paddocks as low worm-risk, so differences between WormBoss and control were often not evident. 2017 and 2018 rapidly moved into the worst drought most people have experienced. This meant that worms were generally, though not always, not a serious issue, but more importantly as paddocks ran out of water and feed, the grazing management options meant to be employed to prepare low worm risk paddocks became impossible to implement for most core producers.

The decision was made to concentrate on obtaining qualitative data about adoption of the practices, rather than economic data, which had already been collected properly in the IPMs project.

Some of the core producers discontinued or were not able to give the program their full attention due to a range of unforeseen difficulties / issues. These issues combined with development of drought made participation difficult.

Despite the difficulties many faced and in seeing obvious differences in results, almost all co-operators considered the program worthwhile for the long term.

### **5.1.2 Exit interviews on adoption**

Overviews of results will be included with future ParaBoss articles that assist producers to implement recommended practices. These will give realistic views of the difficulties one may encounter when trying to adopt the practices.

In regard to the recommended practices it is interesting to note that all encountered difficulties, sometimes significant, in preparing low worm-risk paddocks for their lambing ewes and weaners—this practice is pivotal in achieving good worm control. But despite this most remain committed to it, with 7 out of 8 intending to prepare lambing paddocks and all will prepare weaning paddocks in the future, and not just some paddocks, but those for all lambing ewes and weaners; such is their understanding and belief in the practice.

Nevertheless, their experiences highlight that there can be considerable difficulties to overcome and that expectations must be managed when extending this information to other producers. Most of the difficulties encountered related to either a lack of attention to management detail or to drought creating difficulties in having enough feed to have more flexible paddock use. But as worms are more of a problem in wetter years there is likely to be more paddock use flexibility then.

There was a good uptake of worm egg counting by the core participants, but they experienced similar issues to those expressed at workshops: cost, time, difficulty in collecting samples and time taken to get results. A number of the core participants also chose to do their own counts to overcome some of these difficulties.

All core producers conducted the drench tests, which were a condition of participation in the project. Despite most of them being new to this activity, their feedback—that the tests were very useful and fairly easy to do—is at odds with industry perception. This indicates that persevering with extension of this valuable activity is worthwhile, but that much more consideration of how the extension is done is needed.

The core participants had strongly adopted the use of worm egg count tests as a primary means to determine whether drenching was warranted, and they continued to supplement these with visual assessment. Some still considered tests to be expensive and had chosen to do their own testing. They used the Drench Decision Guide sometimes, generally earlier, but as they became more experienced, they already knew the questions the Drench Decision Guide (DDG) would ask as well as the drenching thresholds and so were able to dispense with formally using the DDGs; which indicates they had learned the key determinants of when to drench.

Having DrenchTest results had a profound effect and most respondents, most of the time had changed their drench choice behaviour as a result, with effective, short-acting combination products being their primary choice. This was an easy change to implement and only one respondent showed price-sensitivity—the new drench choices were often more expensive than their previous choices, but with hard data to support their use, uptake was high.

Interestingly, some old habits are hard to set aside. Despite much evidence presented to the core participants and at workshops indicating that drench rotation had little effect on slowing the development of drench resistance, most respondents still tried to rotate drenches. This is not a harmful action in itself, though it may limit their drench choices, however, what it does show is that the extension campaigns over the last two decades to rotate drenches (which is a simple practice) was extremely successful and ingrained into their psyches.

Many of the participants also use Barbevax vaccine and indicated they do so due to their significant issues with barber's pole worm. Such a need is likely indicative of their interest in the WormBoss program, as a means to overcome their worm problems.

It was very positive to see that many of the participants also used breeding for worm resistance. However, not all and the importance of traits other than worm resistance must be strongly considered.

As expected, and in line with observers, the confidence and knowledge of the core participants increased as a result of participation.

### **5.1.3 Workshops**

While it was intended to run nine workshops, these were reduced to 6.

The plan was to do a set of three workshops (each concentrating on different aspects of worm control) each year and repeat them across the region each of the three years. Certainly, a number of observers attended more than one workshop, but feedback indicated that people had limited time and just wanted to attend one comprehensive workshop, rather than 3 throughout a year.

Another issue was that the region had already received 7 workshops from 2012–2014 delivered by Deb Maxwell and Lewis Kahn. As such by the time 6 workshops were conducted there was the feeling that most of those likely to attend a workshop had already done so.

Finally, the developing severe drought conditions made it inappropriate to run these events. Worms are typically considered a problem associated with rainfall and people were increasingly committed to simply ensuring the survival of their sheep by carting water and feeding stock and were stressed and not open to workshops about worm control.

Nevertheless, 6 workshops were conducted with excellent attendances and very good feedback.

### **5.1.4 Webinars**

In doing fewer workshops it was decided to replace these with some webinars.

Five webinars were developed and delivery of these commenced in May 2019. Four have been delivered at the time of this report and the fifth will be delivered on 10<sup>th</sup> September. The poll conducted in the last webinar indicates they have been well received, with the vast majority of farmers asked to respond to the poll answering that the webinar was very or extremely useful.

After the first webinar a pharmaceutical company requested permission to provide the recording to their staff as a training tool.

Already people are viewing the recordings, which ParaBoss will continue to promote.

In terms of extension and communication, it would have been ideal to have a feature story on the likes of Landline. The drought again has made this an inappropriate activity at this time. ParaBoss could consider this once the drought breaks.

### **5.1.5 Calculating efficacy of multi-actives versus actual testing**

Drench resistance tests are a significant expense that does put people off doing them. As such, testing all the possible drench combinations that might want to be used is too expensive and requires a large number of sheep.

One option is to test only the limited number of single actives then calculate efficacy for multi-actives.

This greatly reduced cost and work and in fact should be considered as also more accurate.

The more sheep data within an analysis reduces the confidence intervals and increases the reliability of results.

Therefore, the calculated results, which use data from more animals, are more likely to reflect the true mean than results of actually testing the multi-active.

Consequently, testing single active drenches and then using the results to calculate the efficacy of a range of multi-active drenches, is recommended.

## **5.2 Communication and extension activities**

Presentations for workshops were prepared and delivered, which encompassed all topics and practices pertinent to worm control in the New England region.

Some of the topic content used for the workshops was amended to produce the five webinars.

During the project, emails (approximately 6 per year, though less in the final year due to drought) were sent to attendees to remind them of pertinent worm control activities.

Core participants and observers were subscribed to ParaBoss News (if they indicated this on the workshop form), and they then received the free twice monthly newsletters.

Five case studies were prepared to highlight the experiences of some of the core producers. These are published on the WormBoss web site. <http://www.wormboss.com.au/news/case-studies.php>



Limited stories were published in newspapers (newspapers weren't very interested).

ParaBoss will use the case studies and the exit interview results as one means to continue to promote worm control practices within Facebook posts, the ParaBoss News. The webinars have become a useful resource and will continue to be promoted and added to by ParaBoss.

ParaBoss requests that MLA does a major story featuring the project and some co-operators for Feedback.

An Invitation to Landline to do a TV story about the project will only be appropriate after the drought breaks.

### **5.3 Changes to producer knowledge and skills**

A significant gain in knowledge was produced in observers (and core producers) by involvement in workshops. The average attendee score beforehand was 43% correct for a quiz about core worm control practices. After, for the same questions, the average score was 79%.

### **5.4 Changes to producer practices**

#### **5.4.1 Changes to observer participants**

When observer producers were asked about the key practice of conducting worm egg counts, only about one quarter of them used them routinely, although half did sometimes. After the workshop the majority of producers either intended to implement them routinely or said it confirmed what they were already doing.

When asked about Drench Resistance Tests, including formal Faecal Egg Count Reduction Tests as well as DrenchChecks (WECs before and after drenching a mob), less than 20% used them as normal practice and a further 15% did them sometimes, but after the workshop 85% either intended to implement them routinely or said it confirmed what they were already doing.

Producers do appreciate the opportunity to attend workshops to learn face to face and have interaction, but are also supporting webinars.

These are positive indications that participants will make some improvements to their practices.

#### **5.4.2 Changes to core participants**

The adoption rate was even higher by the core participants with very high intent to continue with all practices was indicated.

Some activities in an integrated worm control program are more difficult to implement than others.

- Preparing low worm risk paddocks take practice and time to get right. They are most difficult to prepare during times of low feed availability and they require attention to management detail as well as good infrastructure.
- Drench tests are considered valuable and easy, although this does not appear to be the widely held perception.
- Most other practices had the difficulties as anticipated.

### 5.4.3 Practical implications for industry

Of most importance was the finding (from the core producers) that Drench Resistance tests were considered very important and easy to do. However, they have been poorly adopted by industry, but are considered by parasitologists as one of the most important foundations of an effective worm control program.

ParaBoss knows that Virbac conducted an extensive study of practices, including decisions about doing Drench Resistance Tests. A summary of findings was presented to ParaBoss and ParaBoss will take up the opportunity to further investigate their findings to reassess how we promote Drench Resistance Testing, in an effort to overcome the incorrect negative perceptions that are holding back adoption.

Additionally, a poll during our last webinar for the project, on Drench resistance testing (held 13/8/19), indicated reasons for the low uptake. They were able to choose (more than one response) from the following options:

- The drenches I use are all new types, so I know they work
- I know what drenches don't work, so I don't need to test those
- I don't know what benefit a DrenchTest would be
- They are too complex
- They take too long
- They require too much work
- They are too expensive
- I don't know what the process is or how to do the test
- I haven't got anyone to help me do one
- I can't get the drenches required
- I haven't got enough animals for the tests
- I don't want to test single active drenches because I don't normally use them
- I've put it off or never got around to it

All options were chosen about 3 to 5 times, but the two options that were selected more than twice were

- I don't know what the process is or how to do the test
- I've put it off or never got around to it

This suggests, for this incredibly valuable practice, ParaBoss needs to do a campaign to make it clear what is involved and to encourage people to view it as valuable and easy and to stop putting it off.

Of next importance is for ParaBoss to increase the provision of sound advice and information on the practical issues of preparing low worm risk paddocks. These are also extremely valuable practices that have a large impact, are not particularly difficult in theory, but are difficult to manage in practice.

The use of the case studies will be of great use to demonstrate the value of both the aforementioned topics and how the core producers have improved in implementing them.

### 5.4.4 Were the objectives met?

Not all initial objectives were met. Of the amended objectives:

1. 30 producers in the New England area will have implemented the WormBoss program and obtained the following expected benefits:
  - a. Deaths of Merino ewes and lambs from worms decreased by at least 50%.
  - b. Production loss from worms decreased by at least 20%
  - c. Labour requirements for worm control are reduced by up to 30%.
  - d. Cost of worms (combined for expenditure and production losses) decreased by \$4/head for Merinos and \$2/head for crossbreds and non-Merinos.

This was amended to:

- 10 producers in the New England area will have implemented the WormBoss program and would provide extensive feedback on the application of the program in their system.

This was completed

2. A series of activities will have been implemented to increase the skills and confidence of the 30 core- producers and up to 100 other producers in the area to know how and when to correctly:
  - a. Purchase worm-resistant rams;
  - b. Undertake a drench resistance test and drench checks;
  - c. Undertake routine worm tests;
  - d. Prepare low worm risk paddocks for lambing ewes and weaners;
  - e. Move stock to a spelled paddock in a rotational grazing system;
  - f. Make sound drenching decisions based on their Drench Test results, worm egg count results and the time of year, class of sheep etc.

For this objective, 6 out of 9 workshops completed, 4 webinars completed and fifth prepared and scheduled.

3. A comprehensive communication program will have been conducted on project findings So that a further 200 or more producers in the New England region and 1000 or more other producers throughout Australia will be influenced to implement the WormBoss program

For this objective, general communications, email notifications, cases studies, exit interview and final report was completed and will be further promoted. Video/landline type story was not completed

4. Additional data will be collected to demonstrate the value of conducting drench tests solely with single actives and using their results to calculate efficacy for all combination drenches.

This was completed

#### **5.4.5 What could have been improved in the project delivery?**

Improvements were implemented through the amendment of objectives and activities in response to review of progress.

More face to face workshops would have been ideal, as they were extremely well received and popular. However, this was unable to be achieved due to drought.

**Guidelines (please don't type in this section, guidelines must be removed before submission by highlighting this section and then deleting):** Full consideration and interpretation of the results is

required. Structure and wording should be clear and concise. A guide as to what content should be included in the discussion is listed below:

- Inferences and insights from the data relative to previous research;
- Practical implications for industry;
- Unanswered questions/additional research recommended;
- Draft extension messages (if relevant); and
- What could have been improved in the project delivery (what worked, what didn't).

This section must also include discussion of the extent to which each specific project objective was met. This includes writing the project objectives and placing a short summary underneath.

## **6 Conclusions/recommendations**

### **6.1 Future R&D**

This project highlights the continuing need to address the low adoption of drench resistance tests as well as grazing management as an alternative or supplement to chemical control of worms. Both provide major impacts and underpin sustainable worm control.

In particular, funders should seriously consider all options to make drench resistance testing easier to adopt, which includes alternatives to the FECRT process.

All of the other practices promoted through the project are also valuable and should be promoted to industry, but the above two drive the others.

### **6.2 Practical application of the project's insights and implications of for the red meat industry**

The insights apply to all sheep producers in moderate to high rainfall areas.

Grazing management strategies differ across regions, but the same principles apply.

They also apply to the goat industry equally, and to some extent in the cattle industry. Drench Resistance testing will be important, as resistance is now very evident with cattle worms, but grazing management will be less important for cattle.

### **6.3 Development and adoption activities that would ensure the red meat industry achieves full value from the project's findings.**

Simply put, continued strong support of ParaBoss, which currently covers sheep and goats and will soon encompass cattle, is the answer to providing the communication and extension of this information to industry.

Internal, but also external parasites, are the top animal health costs for the sheep industry, next to costs related to losses around birth and weaner growth.

The state departments, universities and CSIRO are moving out of this extension space more and more and ParaBoss has filled the gap.

It is recommended to continue developing more resources to suit different learning styles as well as to assist providers of information and services to industry.

It is also most sensible to support this one entity that works nationally and has a high and growing use.