Final report

Phasing out of mulesing: cost, benefits and opportunities

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Abstract

Mulesing is a surgical procedure that removes wool-bearing folds of skin from the hindquarters of lambs to reduce the risk of flystrike. While mulesing is effective in reducing the risk of breech flystrike, it is a painful procedure that has received public scrutiny and poses potential risk to existing and future market. To help address this issue, the overarching aim of this project was to examine the benefits and costs of ceasing mulesing in the sheepmeat industry, while also examining the key drivers for the continuation of mulesing. This 2.5-year project consisted of four main components 1) a detailed cost and benefit analysis associated with ceasing mulesing in Prime lamb and Merino enterprises, 2) a review of the New Zealand experience with the cessation of mulesing, 3) a detailed assessment of producers' attitudes towards mulesing and barriers to transition to non-mulesed enterprises, and 4) the development of an intervention/extension strategy to support farmers' transition to non-mulesed operations.

The cost: benefit analysis was developed as a 'tool'. Allowing producers to populate a spreadsheet with their own, personalised data, or, in the instance where this is information not available, enterprise- and rainfall-specific data is utilised in its stead. In addition, a series of example scenarios were assessed for both, Prime lambs and Merino enterprises. The main findings of these scenarios indicated a positive cash flow (ranging from $0.33 to $2.19 per DSE, depending on rainfall areas) for Prime lamb enterprises transitioning to non-mulesing compared to continuing mulesing. Further financial benefits however could be added for lamb producers if farms are certified with some programs (e.g., RWS and Authentico) to receive a premium on the price of non-mulesed wool. Another major finding from this research indicated that producer attitudes towards mulesing are important drivers in the decision to run mulesed operations or not. These attitudes comprise behavioural beliefs (the perceived effectiveness/need for mulesing), normative beliefs (the perceived influence of other stakeholders, e.g., shearers prefer mulesed sheep and other farmers are willing to pay more for mulesed sheep), and control beliefs (the perceived ability or difficulty of phasing out mulesing e.g., costly and time consuming). Producers were more likely to run mulesed enterprises if they held more positive views in relation to the importance/effectiveness of mulesing and low trust in alternative strategies to control flystrike (e.g. believe that mulesing is 'the key' to prevent flystrike), if they perceived a high incidence of breech flystrike, if they perceived a high risk of flystrike on their property, if they perceived that shearers and other farmers preferred mulesed sheep (e.g., mulesed sheep are easier to shear and crutch) and if they perceived that running non-mulesed enterprises is difficult (e.g., short- and long- term strategies to control flystrike are time consuming, expensive and affect profitability).

Based on all these results, a potential intervention/extension strategy was developed to support producers in transitioning to non-mulesed operations. The aim of this strategy is to facilitate a transition by increasing knowledge of and trust in short- and long-term strategies to control flystrike, by discussing the cost and benefits associated to phase out mulesing, by trialling its on-farm practicality, and by raising awareness of the risks to social license. Thus, the proposed extension strategy consists of four main components 1) Improving knowledge of and trust in short- and long-term strategies to control flystrike, 2) Provision of tools for decision making, 3) Tailored on-farm trials to encourage the use of short- and long-term strategies to control flystrike and 4) Increasing communication with consumers. Although such as extension program is important to support farmers in a transition to non-mulesed operations, any extension strategy needs to be conducted within a broader industry approach. Thus, the sheep industry (wool and meat) should take a leadership role with a collaborative approach, leading and supporting the transition with a clear position/message and realistic short-term and long-term targets that can be

embraced by key industry stakeholders. A combined effort, that is, working together with key stakeholders, understanding their opinions and concerns regarding phasing out mulesing, in a manner indicative of cooperation, can be an effective strategy to support a transition.

The outcomes of this project translate into two main practical applications. First, the development of a 'tool' that can be use by sheep producers and their advisors that can be integrated into existing or future extension strategies or relevant platforms. Second, the development of an extension strategy that targets key producers' attitudes and barriers to transition to non-mulesed operations. Further studies should trial this extension strategy and measure its effectiveness in supporting farmers transition to non-mulesed operations, or alternatively, key aspects of this strategy should be incorporated into existing extension programs/MLA producer demonstrations sites to support farmers. Further research should also examine the on-farm prevalence of breech flystrike of mulesed versus unmulesed sheep and market/consumer/public risks associated with mulesing being part of the lamb meat supply chain.

Executive summary

Background

Mulesing is considered an effective procedure to reduce the risk of breech flystrike in Australian sheep, particularly in the wool industry. Mulesing, while effective, is a painful procedure that has received public scrutiny and poses potential risks to existing and future markets. With Australian sheepmeat production systems largely dependent on Merino or Merino-crossbred ewes, the issue of mulesing lurks in the background for lamb supply chains and markets, even if the animals sent for slaughter are not themselves mulesed. To help address this issue, the overall aims of this project were to 1) examine the benefits and costs of ceasing mulesing in the sheepmeat industry, and 2) examine producer attitudes towards mulesing and barriers to transition to non-mulesed operations. These results were used to develop a targeted intervention/extension strategy to support farmers transition to non-mulesed operations.

Objectives

This 2.5-year research project had four main objectives: 1) to produce a detailed report on the benefits and costs of ceasing mulesing on sheepmeat enterprises, 2) to produce a detailed review on the New Zealand experience with the cessation of mulesing, 3) to identify the key drivers of farmer behaviour to continue mulesing and barriers for behavioural change to non-mulesed sheepmeat enterprises and 4) to develop an extension strategy to address key drivers of farmer behaviour to support farmers with the transition to non-mulesed operations.

Methodology

In line with the main objectives, this project consisted of four main components:

1) Cost and benefits associated with ceasing mulesing. For this component, a cost:benefit analysis tool was developed. Assumptions used for the cost:benefit analysis model were based on both current on-farm management practices and findings from a producer survey that was developed for this component.
2) A review of the New Zealand experience. For this component, a literature review, and 15 interviews with key New Zealand stakeholders were conducted.
3) Pathways and barriers to adoption. To achieve the aims of this component, a focus group (n=13 participants), phone interviews with producers (n=20), phone interviews with shearers (n=11) and a national producer survey (n=546) were conducted. Key aspects investigated included attitudes, trust and perceived barriers to behavioural change. Data on sources of knowledge e.g., whom farmers rely on for advice were also collected.
4) Intervention/extension strategy. Based on results from component 1, 2 and 3, an intervention/extension strategy was developed to support producers transition to non-mulesed operations. The strategy was designed using a cognitive-behavioural intervention approach.

Results/key findings

The cost: benefit analysis was developed as a producer 'tool'. With this 'tool', producers can populate a spreadsheet with their own, personalised data, or, in the instance where this is information not available, enterprise- and rainfall-specific data is utilised in its stead. This allows producers to estimate their financial position following a phase out of mulesing over 7 years.

As examples, a series of scenarios were assessed for both Prime lamb and Merino enterprises. The main findings of these scenarios indicated a positive cash flow (ranging from $0.33 to $2.19 per DSE, depending on rainfall areas) for Prime lamb enterprises transitioning to non-mulesing compared to continuing mulesing. In both Prime Lamb and Merino enterprises, the extra chemical control is a major contributor to the cost of transitioning to a non-mulesed flock. Further financial benefits however could be added for lamb producers if farms are certified with programs to receive a premium on the price of non-mulesed wool.

Another major finding from this research indicated that producer attitudes towards mulesing are important drivers in the decision to run mulesed operations or not. These attitudes comprise behavioural beliefs (the perceived effectiveness/need for mulesing), normative beliefs (the perceived influence of other stakeholders, e.g., shearers prefer mulesed sheep and other farmers are willing to pay more for mulesed sheep), and control beliefs (the perceived ability or difficulty of phasing out mulesing e.g., costly and time consuming).

Based on all these results, an intervention/extension strategy was developed. The aim of this strategy is to facilitate a transition by increasing knowledge of and trust in short- and long-term strategies to control flystrike, by discussing the cost and benefits associated to phase out mulesing, by trialling its on-farm practicality, and by raising awareness of the risks to social license. Thus, the proposed targeted extension strategy consists of four main components 1) Improving knowledge of and trust in short- and long-term strategies to control flystrike, 2) Provision of tools for decision making, 3) Tailored on-farm trials to encourage the use of short- and long-term strategies to control flystrike and 4) Increasing communication with consumers.

Benefits to industry

There are two main practical applications from the results of this project:

1) The development of a 'tool' that can be use by sheep producers and their advisors, which can be integrated into existing or future extension strategies or relevant platforms.
2) The development of an extension strategy that targets key producers' attitudes and barriers to transition to non-mulesed operations.

Future research and recommendations

Further studies should trial the extension strategy that was developed for this project and measure its effectiveness in supporting farmers transition to non-mulesed operations, or alternatively, key aspects of this strategy (e.g., increasing producer awareness of potential risk to social license) should be incorporated into existing extension programs/MLA producer demonstrations sites to support farmers. Further research should also examine the on-farm prevalence of breech flystrike of mulesed versus unmulesed sheep and market/consumer/public risks (both, national and international risks) associated with mulesing being part of the lamb meat supply chain.

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1. Background

Increasing social demands for assurance of good animal welfare and a general 'social licence to operate' can generate pressure on livestock farmers. Mulesing is one of the most controversial husbandry procedures in the Australian sheep industry, causing public scrutiny and risks to markets. With Australian sheepmeat production systems largely dependent on Merino or Merino-crossbred ewes, the issue of mulesing lurks in the background for lamb supply chains and markets, even if the animals sent for slaughter are not themselves mulesed.

There is a considerable body of work on the benefits of mulesing for Merino sheep in relation to the risks of flystrike. These benefits vary according to season, underlying fly-risk of the farm environment, and sheep type. Sheep type has been further quantified in terms of flock averages and variation in traits such as breech and skin wrinkle, breech cover and dag scores, and valuable information has come from projects such as the Merino selection flocks managed by DAFWA at Mt Barker and CSIRO in Armidale. This and other work have been further synthesised in cost benefit analyses, although some of these are now no longer current (e.g., Counsell 2000), or are focused on particular areas. Most of this work has been focused on the wool industry. Previously, the Mackinnon Project through Dr John Larsen, in conjunction with AWI, examined the barriers that can prevent Merino wool producers from ceasing mulesing. Given that Merino sheep form the base of much of Australia's sheepmeat production, there is the need to further examine the approaches to cease mulesing in relation to lamb production. There is also the opportunity to build on existing work by Mackinnon on cost:benefit analyses around mulesing.

In addition to undertaking the cost:benefit analysis, there is another important knowledge gap – which is the understanding of the drivers for continuing mulesing and possible barriers for adoption of change. Understanding the key drivers that underpin farmer behaviour to mulesing provides the opportunity, through targeted education, training and policy, to improve/change farm practices (Hemsworth et al. 2002; Wells et al. 2011).

Accordingly, there is a need to examine the benefits and costs of ceasing mulesing in the sheepmeat industry, while also examining the key drivers for farmer behaviour towards continuation of mulesing, and possible barriers for behavioural change towards non-mulesed systems. These outcomes can inform future extension programs on appropriate approaches to encourage phasing out mulesing in the sheep industry.

2. Objectives

This research project had four main objectives:

Objective 1: To produce a detailed report on the benefits and costs of ceasing mulesing on sheepmeat enterprises. Completed.

Objective 2: To produce a detail review on the New Zealand experience with the cessation of mulesing. Completed.

Objective 3: To identify the key drivers of farmer behaviour to continue mulesing and barriers for behavioural change to non-mulesed sheepmeat enterprises. Completed

Objective 4: To develop an extension strategy to address key drivers of farmer behaviour to support farmers with the transition to non-mulesed operations. Completed

Project timeframe

In line with the main objectives, this project consisted of four main components. 1) Cost and benefits associated with ceasing mulesing, 2) A review of the New Zealand experience, 3) Pathways and barriers to adoption, and 4) Intervention/extension strategy.

Component 1: Cost and benefits associated with ceasing mulesing

- Development of a Cost:Benefit analysis tool **2019-2022**

Component 2: The New Zealand experience with the cessation of mulesing

- A review of the New Zealand experience **2019-2020**

Component 3: Pathways and barriers to adoption

- Identification of producers' attitudes towards phasing out mulesing and barriers to adoption
- Identification of shearers' opinions **2019-2021**

Component 4: Intervention/extension strategy

- Development of an extension strategy to support farmers transition to non-mulesed operations **2021-2022**

The main components of the project are presented in the following sections (section 3 to 6). Each component is presented separately to facilitate the reading of this final report. Section 3 presents the methodology, key findings and take-home messages of the cost:benefit analysis. Section 4 presents the methodology, key findings, and take-home messages of the New Zealand experience. Section 5 presents the methodology, key findings and take-home messages of the component 'pathways and barriers to adoption'. Finally, section 6 presents the structure of an extension/intervention strategy based on the key findings of this study.

3. Cost and benefits associated with ceasing mulesing

3.1 Methodology

The cost:benefit analysis model of this project included (but was not limited to): production losses associated with breech strike, farm management practices (shearing, crutching, use of chemicals, labour, etc.), cost of treating breech flystrike and an allowance for sale premiums and discounts of non-mulesed stock and non-mulesed wool.

Assumptions used for the cost:benefit analysis model were based on both current on-farm management practices and findings from a producer survey that was developed for this component (see Appendix, section 10.1). Details of the assumptions used are presented below.

3.1.1 Instructions for use of the Cost: Benefit Analysis Model

The cost: benefit analysis model allows producers to input information and answer questions in the associated spreadsheet in the cells highlighted in yellow. To avoid any inadvertent adjustments to formulas, the workbook has been locked to prevent adjustment of all cells except those highlighted in yellow. Where required and outlined in the model, some cells also only permit certain answers (e.g., "AT" sheds or "NOT" at sheds for crutching in cell B:50) These can be chosen from a drop-down menu when the cell is selected.

Producers begin by selecting their most relevant enterprise and rainfall type in cell B6 (Merino, Prime Lamb, Winter-dominant, Summer-dominant or Uniform Rainfall). Due to the vast differences both within and between breeds in DSE ratings, producers are given the option to insert their own DSE ratings. Where producers are unsure of approximate DSE ratings for stock classes, a reference table is provided to source DSE ratings. **Stock numbers should be completed as at the time of lamb marking.**

Wool price (Micron Price Guide - MPG): Wool price is listed in cell B22. It should be noted that this wool price is specifically without a non-mulesed premium applied. A non-mulesing premium can be applied to the wool price in cell B25.

Stock sales and Meat Income: Information on stock sales can be provided on either a $/head value or a c/kg cwt value. Where the $/head value is greater than $0, this value will be used over a c/kg cwt value. Where both the $/head and c/kg cwt values are omitted or listed at $0, stock sale values will be drawn from a standard reference table based on enterprise type (Merino or Prime Lamb). These values are based on standard values provided in the 2018-2019 Victoria Livestock Farm Monitor Project Report (Agriculture Victoria, 2019).

Industry surveys and discussion with relevant brokers and agents presented in the Milestone 1 report indicated that if a phase-out of mulesing was to occur in Australia, then any initial premiums/discounts would be phased out over the relevant period. As a result, the final 7-year analysis of an enterprise's mulesing phase-out plan includes the option to also select for a 7-year phase-out of all non-mulesing premiums and/or discounts (see cell B:126).

Shearing

Base wool production for weaners in Merino enterprises was assumed to be 3kg (GFW), but the figure will depend on when weaners are shorn. For example, if weaners were spring born and shorn in Dec (at 3 months old) then they will likely produce 1 kg GFW. If weaners were shorn the following winter (with 6-8 months wool) weaner wool production is likely to be 2.5 to 3 kg GFW. Producers can alter this for their flock

Shearing costs have been calculated from an analysis of the Pastoral Award 2010, last published on April 20, 2020. The model allows for the producer to select the scenario which best fits their "normal" shearing team. As a result, producers can select the number of shearers, number of shed-hands, and whether there is a paid presser and wool-classer. Note also that the model includes an option for selecting a shearing contractor premium as a % of the total cost per head ("Producer Tool_CBA Mulesing" cell A:74). A full breakdown of shearing cost assumptions can be viewed in the appendices, section 10.1.1 Pay rates have been calculated from the Pastoral Award as follows:

- Shearer's rate: $4.92 per head, based on award rate of $398.28 per 100 head for stock which are not double fleeced, machine shearing and the shearer provides their own stud comb. The rate per head also includes an additional 9.5% for super, and WorkCover loading at the standard Victorian shearing WorkCover industry rate of 14% (source: https://www.worksafe.vic.gov.au/resources/workcover-insurance-industry-rates-and-industry-claims-cost-rates-201920).
- Shed-hand, wool presser, and classer rates have also been included in the cost per head calculation based on the below costs, which include superannuation and WorkCover loading as for shearers:
    - Shed-hand: $74.45 per run, based on standard rate for adult shed-hand with > 65 days experience of $60.28 per run, plus WorkCover loading of 14% and 9.5% superannuation
    - Wool Classer: $361.65 per day, based on pastoral award rate of $292.83 per day (Level 2 classer), plus 14% WorkCover loading and 9.5% superannuation.
    - Wool presser: $78.00 per run, based on pastoral award rate of $63.78 per run, plus 14% WorkCover loading and 9.5% superannuation.
- An additional travel allowance has been provided for each shearer and contractor, based on standard travel of 100 km per person per day at $0.78 per km.

Note that rams are charged at twice the ewe rate, as required by industry award. In addition, an allowance is made to select the % longer shearing for non-mulesed versus mulesed stock ("Producer Tool_CBA Mulesing" cell A:75). Currently, there is no standard increased cost for shearing non-mulesed sheep, however the option to select for an increased shearing cost has been included should industry trend towards this due to longer shearing times for non-mulesed sheep.

This allowance in the tool allows the model to consider different management practices on between operations. For example, some non-mulesing producers may undertake a pre-shearing crutching, and as a result there will be minimal increase in shearing time for these producers. However, some producers may opt to not undertake a pre-shearing crutching, this may result in additional dag at shearing, increasing shearing time per head. As outlined in B.AWW.0006 Milestone Report 1, Horton (2007) found

non-mulesed hoggets required 36% longer to crutch (due to additional dag). A further study (Smith et al., 2010) found that 12-month-old non-mulesed sheep required 21-28% more time to crutch for every increase in dag score above 2. Tyrell (2013) found that the time taken to crutch mulesed Merino's ranged from 15-57 seconds, whilst non-mulesed took 33-109 seconds. Tyrell (2013) also evaluated the time taken to crutch mulesed versus non-mulesed Merinos in sheds and trailers. For trailer crutching, non-mulesed sheep took 93-151% longer to crutch through a trailer than mulesed sheep. For shed crutching, non-mulesed sheep took 33-58% longer to crutch through a shearing shed than mulesed sheep. Non-mulesed sheep had more dag and breech wrinkle, which made them more difficult to crutch. Consequently, the cost of crutching non-mulesed sheep will increase to take account of the reduced numbers of sheep that can be crutched per day.

Furthermore, additional wool was removed from the non-mulesed sheep with an increased proportion of pieces at the subsequent shearing, ultimately decreasing the income from wool. Note that the additional cost of shearing due to longer time for shearing is not automatically inserted into the final analysis. Producers must select "Yes" in cell B:125 in response to the question in cell A:125 of "Apply additional costs for longer shearing of non-mulesed sheep compared to mulesed (Yes/No)?" for the additional cost of shearing to be included.

Wool loss due to reduced fleece weight of struck sheep

It was assumed that fleece weights are 5% lighter for struck sheep (Colditz 2005; Broadmeadow 1983; Raadsma 1984). Application of a discount for low staple strength of struck wool, and calculation of wool loss from tender wool (low staple strength) discounts was also included, assuming 50% of struck sheep have tender wool (Colditz 2005). Producers are able to enter these figures based on a 5-year AWEX auction analysis of low staple strength discounts to April 2022 (Table 1). A multiplication factor of 0.95^2 was included in the cost of reduced fleece weight in struck sheep to account for the lower value of locks and pieces.

Table 1. Five-year AWEX auction analysis of low staple strength discounts to April 2022

Staple Strength (N/ktex)	Super-fine (<16micron)	Fine-to-medium (17-21 micron)	Strong (>20 micron)
< 20	9%	4%	0%

Crutching

As for shearing, crutching costs are based on the Pay Guide - Pastoral Award 2010, last published April 20,2020. A full breakdown of crutching costs can be viewed in the appendices, section 10.1.2
The tool allows producers to select for crutching to occur 'at sheds' or 'not at sheds', as per the Pastoral Award ("Producer Tool_CBA Mulesing" cell A:45). Additionally, the tool also allows for producers to select if a contractor's premium is applied to the total cost of crutching ("Producer Tool_CBA Mulesing" cell A:52). The cost per head is based on the Award rate of $92.40 per 100 head for sheep crutched at sheds with no wigging or ringing or $79.66 per 100 head for sheep crutched not at sheds.

- Crutching costs assume 500 head crutched per day and includes 0.5 shed hands per crutcher at the adult shed-hand rate for those with > 65 days experience ($60.28 per run).

- As for shearing costs, a travel allowance of $0.78 per shedhand and Crutcher has been factored in, assuming 100 km return travel per contractor per day.
- As for shearing costs superannuation at 9.5% and WorkCover loading as per the 2019/2020 Victorian Worksafe requirements has been factored into the cost per head.

Mulesing costs

Mulesing costs were estimated based on a review of veterinary prescription pricing for S4's (such as Metacam 20 injectable and Buccalgesic oral), over the counter pricing from rural retailers (Tri-solfen®) and communications with mulesing contractors in central Victoria regarding price charged for mulesing procedure. As with the above shearing and crutching costs, a full breakdown of associated mulesing costs has been included in appendix section 10.1.3. Tri-solfen®, Buccalgesic and Metacam dose rates were based on estimated lamb weight of 10 kg at lamb-marking.

In accordance with the Victorian Prevention of Cruelty to Animals Act (POCTA, 2019) an additional note has been added to the Producer Tool (cell A:62) indicating that as of 2019, use of pain relief when mulesing stock in Victoria is mandatory. There is also provision for producers to enter the percentage of lambs mulesed (A:63) (for example, for prime lamb flocks mulesing only ewe lambs to be kept as replacements).

Chemical prevention of breech flystrike

Due to increasing evidence around emergence of resistance to commonly used chemicals, it is possible for the model to be manipulated to allow for dual treatments to be used (e.g. one treatment, with both dicyclanil and ivermectin). This is due to increasing reports of resistance to key chemical classes used for prevention of breech flystrike, including insect growth regulators (e.g., cyromazine, dicyclanil) and macrocyclic lactones (e.g., ivermectin) (Levot 2014). A full breakdown of chemical costings can be viewed in appendix section 10.1.4, including cost of product, application rates and product cost per DSE.

A labour cost of $0.20 per head has been allocated for each chemical treatment. Note that due to the wide variety of different treatment methods and implements available across Australia (e.g. Electrodip, standard jetting crates, race-way treatment) no depreciation allowance has been included.

Cost of additional Dag

The producer tool allows producers to select the assumed difference in dag score for sheep in mid-spring between mulesed and un-mulesed stock. In the prime lamb scenarios, the average dag score of unmulesed sheep was assumed to be one dag score higher than mulesed sheep. The cost of additional dag is drawn from research undertaken from Larsen et al. (1995) and has been adapted using 2019/20 recommended wages. The costs associated with dag are further calculated in the model from the micron price stipulated by producers in the tool (cell B:22) to allow for variation in the cost of dag between different micron values. The relative cost of dag can be viewed in this document in appendix section 10.1.5.

The percentage discount of crutchings from ewes with dag score < 1 and those with dag score > 2 is drawn from the same research undertaken by Larsen et al. (1995) and relates to a discount compared to fleece value. Due to the significant variability in breech wrinkle and dag score across bloodlines (specifically Merino) and breeds, producers can select the size in grams of the larger crutch volume per DSE for mulesed compared to un-mulesed stock for their own individual enterprise.

Breech flystrike estimates (mulesed vs non-mulesed)

Producers are given the option in the breech flystrike tool to select their own estimated percentage of breech flystrike in mulesed and non-mulesed stock. Where producers do not have this information at hand, or instead wish to use data provided, breech flystrike estimates are made based on the survey data received from producers as part of the associated Milestone 1 report. The median breech flystrike rate from this survey for mulesing and non-mulesing Prime Lamb and Merino flocks can be viewed in appendix section 10.1.6.

Data automatically inputs into the producer tool depending on the enterprise type (Merino or Prime Lamb) and dominant rainfall type (winter-, uniform- or summer-dominant rainfall). These estimates are taken from results provided in the producer survey conducted as part of Milestone 1 of this project. None of the prime lamb survey respondents from Milestone 1 from uniform rainfall regions indicated that they currently mules. As a result, the value of breech flystrike % for mulesing prime lamb enterprises has been estimated as half the average (2.5%) for winter-dominant (3.0%) and summer-dominant (2.5%) rainfall areas, respectively.

The influence of genetics on breech flystrike rates has not been directly included in this model due to the wide array of bloodlines and variability between different breeds. However, producers can adjust for breed differences through adjusting breech flystrike estimates for both mulesed and non-mulesed stock in the model (cells B102, B103).

It should be noted that the estimated of breech flystrike in Prime Lamb enterprises that are currently mulesing may be unreliable, as only one prime lamb respondent from each of the winter- and summer-dominant rainfall areas reported that they continue to mules.

Flystrike treatment cost assumptions

Flystrike treatment assumptions have been based on approximate retail pricing of S4 prescription remedies (Buccalgesic oral, Metacam 20 injectable, Alamycin LA 300, Oxytet 200 LA) from veterinary clinics and over the counter products sourced from rural retailers (Extinosad Eliminator, Ivermectin). All on-farm labour costs have been estimated at a rate of $30 per hour. Dose rates have been calculated on a cost per DSE basis and are then adjusted to a per head basis when fed back into the producer tool equations. These rates are included in this report under appendix section 10.1.7.

Sale costs

Due to the focus of this project being on Prime Lamb enterprises, it is necessary to include the option for a sales premium or discount for sale of non-mulesed versus mulesed stock. This then allows producers to

enter their own specific sales premium or discount and influence the final results. In the sample scenarios, the non-mulesed liveweight premium/discount was assumed to be 0% for both Prime Lamb and Merino enterprises in all rainfall areas, however this has been further addressed in Section 3.4 of this report.

Producers are given the option to include sale prices based on sale price per head (i.e. through saleyards, AuctionsPlus) or based on cents per kg dressed weight (c/kg cwt). Note that the value for cents per kg dressed weight is only factored in when the sale price per head is either not given or is marked as "$0". Where sale prices are not inserted on either a $/head or a c/kg cwt basis, then a standard sale value is inserted, determined by whether the enterprise is either a Merino or Prime Lamb enterprise. These values have been taken from the standard values given in the Victorian Livestock Farm Monitor Report (Agriculture Victoria, 2019).

The sample models presented below provide a broad overview of the two most contrasting sheep enterprises in Australia: wool-producing Merino flocks and Prime Lamb enterprises. Both Merino and Prime Lamb enterprises have been modelled to different rainfall distributions of winter-dominant, summer-dominant and uniform rainfall distributions.

3.2 Scenarios run in the Cost:Benefit Analysis Model

Several example scenarios were modelled using the producer tool developed for this report. Scenarios were run based on answers provided by survey respondents in the mulesing survey undertaken as part of Milestone 1 for this project. A total of six broad scenarios have been outlined below based on enterprise type (broadly categorised into "Prime Lamb" and "Merino") and rainfall distribution (winter-dominant, summer-dominant or uniform), including:

- Prime Lamb, Winter-Dominant Rainfall
- Merino, Winter-Dominant Rainfall
- Prime Lamb, Uniform Rainfall
- Merino, Uniform Rainfall
- Prime Lamb, Summer-Dominant Rainfall
- Merino, Summer-Dominant Rainfall

Note that due to there being a relatively small representation of some industry groups in survey respondents (particularly Prime Lamb enterprises mulesing in uniform rainfall areas) this data should provide an indication only of the cost of ceasing mulesing in relation to producer survey responses from Milestone 1. A standard flock size of 3,000 ewes (including replacements) has been applied to the model. For Merino enterprises, it has been assumed that a portion of 2,000 wethers are retained for wool production (1,000 wether weaners retained per year, sold at 3-4 years of age). No wethers have been retained for Prime Lamb enterprises in the model below. A 5% overall background mortality was assumed in all flocks. Marking rates of 95% and weaning rates of 90% have been assumed for Merino's in the below model. Rates of 120% and 118% have been applied to Prime Lamb enterprises for marking and weaning rates, respectively. Note that these values will vary widely across differing operations and genotype/phenotype.

The base self-replacing Merino and Prime Lamb flock structure used in in the cost: benefit analysis model, their sale weights and dressing percentages, are outlined in

Table **2** through to

Table 5Error! Reference source not found..

Table 2. Merino flock structure for case scenarios run through the cost: benefit analysis model

Stock Class	**Stock Number**
Ewes	3,000
Lambs	2,850
Weaners	2,700
Wethers	2,000
Rams	70
Total	10,620
Total stock minus lambs	7,770

Table 3. Number of stock sold, sale weight and dressing percentage for Merino case scenarios run through the cost: benefit analysis model

Stock class	Stock Sold per annum	Sale weight (kg)	Dressing %
Ewes	630	50	40%
Lambs	0	30	45%
Weaners	900	35	45%
Wethers	950	55	41%
Rams	26	70	40%
Total	2,506		

Table 4. Prime lamb flock structure for case scenarios run through the cost: benefit analysis model

Stock Class	Stock Number
Ewes	3,000
Lambs	3,600
Weaners	3,540
Wethers	0
Rams	70
Total	10,210
Total stock minus lambs	6,610

Table 5. Number of stock sold, sale weight and dressing percentage for Prime Lamb case scenarios run through the cost: benefit analysis model

Stock class	Stock Sold per annum	Sale weight (kg)	Dressing %
Ewes	650	65	40%
Lambs	0	45	45%
Weaners	2,740	45	45%
Wethers	0	N/A	41%
Rams	26	80	40%
Total	3,416		

In addition to those outlined in section 3.1.1 of this report, assumptions for both Prime Lamb and Merino models for all rainfall distributions include:

- Use of Tri-solfen® on mulesing wounds has been applied as standard due to the Victorian requirement for mandatory pain relief when mulesing stock (under the Prevention of Cruelty to Animals Act: 2019). This can be adjusted in the producer tool if required for mulesing producers in other states.
- Rams are sold at 4 years of age.
- 600 ewe weaners are selected as replacement ewes annually (800 in prime lamb flocks)
- Ewes are cast-for-age at 6 years of age.
- Livestock in the below models have had applied a standard sale value based on values provided in the 2019 Victorian Livestock Farm Monitor Project report and are included in appendices below under section 10.1.6.
- No additional cost has been allocated for longer shearing of non-mulesed sheep compared to mulesed sheep.
- A 7-year phase-out period of mulesed stock on-site has been allocated for both Prime Lamb and Merino enterprises, with standard Consumer Price Index (CPI) of 2.50%. A 7-year phase-out of any initial premiums and discounts for non-mulesed stock and wool sales has also been applied to both Prime Lamb and Merino models.
- The estimated mortality rate in breech flystrike (Cell B103) was assumed to be 10%, based on field observations and data from Lucas & Horton (2013). No other references were found regarding death rate of struck sheep.

Standard DSE rating estimates used for the below models are outlined in the appendices under section 10.1.7, however can be adjusted by producers where required using the tool. Note that lambs are classified as unweaned lambs, and as a result their DSE rating is incorporated within ewe DSE ratings. Weaned lambs should be classified as “Weaners” under “Stock Information”.

Further assumptions for the Merino models include:

- The balance of ewe weaners not selected as replacement ewes and wether weaners not retained for wool-production are sold as weaners.
- Crutching occurs “not at sheds” (e.g. using a crutching trailer), with a 50 gram (clean fleece weight) larger crutch volume for non-mulesed compared to mulesed Merino’s (Larsen et al., 1995).
- Dag Scores and cost of dag are based on the scoring system utilised and financial implications outlined by Larsen et al. (1994). Financial costs have been standardised by CPI to current-day values.
- A total of 4 shearers, shearing at 200 head per shearer per day, assisted by 2 shed-hands (adult shed-hand, greater than 65 days experience), 1 wool-presser and 1 wool classer (level 2). No additional shearing contractor’s premium has been applied.
- Due to the recent highly volatile wool market, Merino wool prices were based on the long-term average of AWEX wool prices for 17-micron wool from October 2003 to June 2020 at an average of 1743 cents per kilogram clean fleece weight (CFW) (Nutrien, 2020).
- Fleece yields of 5 kg greasy fleece weight (GFW) for Merino ewes, 5.5 kg GFW for Merino wethers and 6 kg GFW for Merino rams.
- A 50-gram increase in crutching area is required for non-mulesing Merino enterprises.

Further assumptions for the Prime Lamb models include:

- The balance of ewe weaners not retained as replacements and wether weaners are sold as stores.
- In mulesed flocks, only the ewe lambs are mulesed (i.e. not wether lambs).
- A total of 4 shearers, shearing at 200 head per shearer per day, assisted by 2 shed-hands (adult shed-hand, greater than 65 days experience) and one wool-presser. No wool classer has been allocated for in the Prime Lamb models. No additional shearing contractor’s premium has been applied.
- Due to the recent highly volatile wool market, Merino wool prices were based on the long-term average of AWEX wool prices for 28-micron wool from July 1996 to June 2020 at an average of 613 cents per kilogram clean fleece weight (CFW) (Nutrien, 2020).
- Fleece yields of 4.5 kg GFW for prime lamb ewes, 2.5kg GFW for weaners and and 5 kg GFW for prime lamb rams.
- There is no larger crutching area for non-mulesed Prime Lamb enterprises, but a difference in average dag score of 1 score (average score 2 in non-mulesed sheep compared to average score 1 in mulesed sheep).

3.3 Key findings

3.3.1 Prime Lamb, Winter-Dominant Rainfall

- Based on survey respondents from Milestone 1 of this project, and common industry practices, further assumptions for winter-dominant rainfall Prime Lamb enterprises (in addition to those outlined above), include:
- Breech flystrike rates of 3.0% for Prime-Lamb producers’ mulesing in winter-dominant rainfall areas.
- Breech flystrike rates of 0.5% for non-mulesing Prime-Lamb producers’ in winter-dominant rainfall areas.
- Non-mulesed wool premium/discount: 0%
- Non-mulesed stock sale premium/discount: 0%

- Increased inspection frequency for non-mulesed stock (weekly): 0
- Pain relief for mulesing: Tri-solfen®
    - Treatment for breech flystrike: Chemical treatment with Extinosad® Eliminator (25g/L Spinosad); trim wool
    - Additional prevention of breech flystrike, including:
        - Additional chemical use: 1 additional treatment with Cyromazine Jet or dip, 500g/L
        - Additional crutchings: Nil

The full model output transitioning to a non-mulesed flock for a Prime Lamb enterprise in a winter-dominant rainfall area is contained in the appendices under section 10.2.1. Table 6 below outlines the net present value for the flock and per DSE. In this analysis, over 7 years, this transition results in a benefit of $24,229.38 for a 3,000 ewe enterprise, or $2.19 per DSE.

Based on the survey results from Milestone 1, mulesed Prime Lamb flocks had a higher breech flystrike percentage than non-mulesed flocks. Whilst this is highly likely to be due to variation in management practices, genetics or other factors from survey respondents, it does indicate that Prime Lamb producers in winter rainfall regions of Australia may not experience substantial costs when transitioning to a non-mulesed enterprise if breech flystrike is well controlled, as the increased costs associated with the higher dag score and preventative chemical application are outweighed by the benefits of decreased breech strike prevalence and lack of mulesing costs.

As stated earlier in this report, some caution should be exercised given the relatively small sample size of survey respondents, which may not reflect long term industry outcomes. Furthermore, if breech flystrike control is not properly implemented when flocks transition to being non-mulesed, the impact of not mulesing may be higher than that observed in survey respondents, due to increased breech flystrike. The difference in cost will also be smaller if non-mulesing flocks continue to use pain relief at lamb marking, for castration and tail docking. However, whilst there are no fleece or stock sale premiums included in this analysis, there is an opportunity for producers to receive a premium on the price of non-mulesed wool if farms are certified with some programs, and this would lead to additional financial benefits.

Table 6. Summary of net present value for transitioning to a non-mulesed Prime Lamb enterprise in a winter-dominant rainfall area over 7 years.

	NPV
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing	$24,165
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing (per DSE)	$2.19

3.3.2 Merino, Winter-Dominant Rainfall

Based on survey respondents from Milestone 1 of this project, further assumptions for winter-dominant rainfall Merino enterprises (in addition to those outlined above), include:

- Breech flystrike rates of 0.6% for Merino producers' mulesing in winter-dominant rainfall areas.

- Breech flystrike rates of 1.1% for non-mulesing Merino producers' in winter-dominant rainfall areas.
- Non-mulesed wool premium/discount: Average of 6.6%
- Non-mulesed stock sale premium/discount: 0%
- An average dag score of 3 (out of 5) in mid-spring for non-mulesing Merino enterprises, compared to an average dag score of 1 for mulesing enterprises.
- Increased inspection frequency for non-mulesed stock (weekly): Nil
    - Pain relief for mulesing: Tri-solfen®
    - Treatment for breech flystrike: Chemical with Extinosad® Eliminator (25g/L Spinosad), trim wool
    - Additional prevention of breech flystrike, including:
        - Additional chemical use: 1 additional treatment with Cyromazine Jet or dip, 500g/L
        - Additional crutchings: 1 additional crutching (ewes, wethers and rams only)

The full model output transitioning to a non-mulesed flock for a Merino enterprise in a winter-dominant rainfall area is contained in the appendices under section 10.2.2. The findings shown in **Error! Reference source not found.** & **Error! Reference source not found.** indicate that where the initial non-mulesed wool premium of 6.6% is phased out over the 7-year period, it is estimated that phasing out mulesing will cost a producer with a 3,000 ewe self-replacing Merino flock approximately $76,499, or $8.19 per DSE. In winter-dominant rainfall areas, an additional crutch and chemical treatment increase the costs of transitioning to a non-mulesed flock, but the largest cost is due to wool loss from increased dag score and a larger crutch area for non-mulesed Merinos. Where non-mulesed wool premiums are not phased out over the 7-year period, a premium of 6.6, as taken from the survey, resulted in a benefit of $14,765 over the 7-year transition period (**Error! Reference source not found.**).

Table 7. Summary of net present value for transitioning to a non-mulesed Merino enterprise in a winter-dominant rainfall area over 7 years. For this table, there has been a staged phase-out of the initial 6.6% non-mulesing wool premium over the 7-year period

	NPV
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing	-$76,499
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing (per DSE)	-$8.19

Table 8. Summary of net present value for transitioning to a non-mulesed Merino enterprise in a winter-dominant rainfall area over 7 years. The output in this table assumes that the initial 6.6% non-mulesed wool premium remains over the 7-year period and is not phased out as in Error! Reference source not found.

	NPV
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing	$14,765

Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing (per DSE)	$1.58

3.3.3 Prime Lamb, Uniform Rainfall

Based on survey respondents from Milestone 1 of this project, further assumptions for uniform rainfall Prime Lamb enterprises (in addition to those outlined above), include:

- Breech flystrike rates of 2.5% for Prime Lamb producers' mulesing in uniform rainfall areas. Note that no Prime Lamb, uniform rainfall survey respondents reported mulesing stock. As a result, breech flystrike estimates for mulesed stock have been matched as halfway between % breech flystrike mulesed for Prime Lamb enterprises from winter and summer dominant rainfall areas.
- Breech flystrike rates of 0.2% for non-mulesing Prime Lamb producers in uniform rainfall areas.
- Non-mulesed wool premium/discount: 0%
- Non-mulesed stock sale premium/discount: 0%
- Increased inspection frequency for non-mulesed stock (weekly): 0
- Pain relief for mulesing: Tri-solfen®
- Treatment for breech flystrike: Chemical treatment with Extinosad® Eliminator (25g/L Spinosad), Trim wool
- Additional prevention of breech flystrike in non-mulesed flocks, including:
    - Additional chemical use: Additional chemical use: 1 additional treatment with Cyromazine Jet or dip, 500g/L
    - Additional crutchings: Nil

The full model output regarding transitioning to a non-mulesed Prime Lamb enterprise in a uniform rainfall area is contained in the appendices under section 10.2.3.

Table **9** below outlines the overall net present value calculation for a Prime Lamb enterprise in a uniform rainfall area transitioning from mulesed to non-mulesed. Whilst there are no fleece or stock sale premiums included in this analysis, the lower reported rate of breech flystrike in non-mulesed Prime Lamb flocks in uniform rainfall areas compared to mulesed flocks means that over 7 years results in a gain of $21,430.19 for a 3,000-ewe enterprise, or savings of $1.94 per DSE. Based on the survey results from Milestone 1, mulesed Prime Lamb flocks had a higher breech flystrike percentage than non-mulesed flocks. Whilst this is highly likely to be due to variation in management practices, genetics or other factors from survey respondents, it does indicate that Prime Lamb producers in uniform rainfall regions of Australia may not experience substantial costs when transitioning to a non-mulesed enterprise if breech flystrike is well controlled.

As stated earlier, some caution should be exercised given the relatively small sample size of survey respondents that may not reflect long term industry outcomes. For example, if breech flystrike control is not properly implemented in flocks transitioning away from mulesing, the impact of not mulesing (on breech flystrike prevalence in the flock) may be higher than that observed in survey respondents. Furthermore, the difference in cost will be smaller if non-mulesed flocks continue to use pain relief at lamb marking. However, whilst there are no fleece or stock sale premiums included in this analysis, there is an opportunity for producers to receive a premium on the price of non-mulesed wool if farms are certified with some programs, and this would lead to additional financial benefits.

Table 9. Summary of net present value for transitioning to a non-mulesing Prime Lamb enterprise in a uniform rainfall area over 7 years.

	NPV
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing	$21,430
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing (per DSE)	$1.94

3.3.4 Merino, Uniform Rainfall

Based on survey respondents from Milestone 1 of this project, further assumptions for uniform rainfall Merino enterprises (in addition to those outlined above), include:

- Breech flystrike rates of 1.0% for Merino producers' mulesing in uniform rainfall areas.
- Breech flystrike rates of 0.5% for non-mulesing Merino producers' in uniform rainfall areas.
- Non-mulesed wool premium/discount: 0%
- Non-mulesed stock sale premium/discount: 0%
- An average dag score of 3 (out of 5) in mid-spring for non-mulesing Merino enterprises, compared to an average dag score of 1 for mulesing enterprises.
- Increased inspection frequency for non-mulesed stock (weekly): 0
- Pain relief for mulesing: Tri-solfen®
- Treatment for breech flystrike: Chemical treatment with Extinosad® Eliminator (25g/L Spinosad), trim wool
- Additional prevention of breech flystrike in non-mulesed flocks, including:
    - Additional chemical use: 1 additional treatment with Cyromazine Jet or dip, 500g/L
    - Additional crutchings: Nil

The full model output regarding transitioning to a non-mulesed Merino enterprise in a uniform rainfall area is contained in the appendices under section 10.2.4. Based on the survey results from Milestone 1 of Merino producers in uniform rainfall areas, no non-mulesed wool premium has been applied to the model. **Error! Reference source not found.** shows that phasing out of mulesing for Merino producers in uniform rainfall areas will cost an estimated $84,772 or $9.08 per DSE over the 7-year phase-out period. Based on the survey results from Milestone 1, mulesed Merinos had a higher breech flystrike percentage than non-mulesed Merinos. Whilst this is highly likely to be due to variation in management practices, genetics or other factors from survey respondents, it does indicate that the cost due to a higher dag score in the unmulesed group outweighed the total change in breech flystrike treatment costs and wool loss.

Some caution should be exercised given the relatively small sample size of survey respondents. It would be expected that dag score in uniform rainfall areas would be lower than winter-dominant rainfall areas (survey results indicated the same dag scores) due to *Trichostrongylus vitrinus,* a major cause of scour and hence dag on sheep in winter-dominant areas, not being as prevalent in uniform rainfall areas.

Table 10. Summary of net present value for transitioning to a non-mulesed Merino enterprise in a uniform rainfall area over 7 years. Note that no wool or stock premium has been applied to the outputs for this model, and as a result there is no effect of phasing out of premiums across the 7-year period.

	NPV
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing	-$84,772
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing (per DSE)	-$9.08

3.3.5 Prime Lamb, Summer-Dominant Rainfall

Based on survey respondents from Milestone 1 of this project, further assumptions for summer-dominant rainfall Prime Lamb enterprises (in addition to those outlined above), include:

- Breech flystrike rates of 2.0% for Prime Lamb producers' mulesing in summer-dominant rainfall areas.
- Breech flystrike rates of 1.0% for non-mulesing Prime Lamb producers' in summer-dominant rainfall areas.
- Non-mulesed wool premium/discount: 0%
- Non-mulesed stock sale premium/discount: 0%
- Increased inspection frequency for non-mulesed stock (weekly): 0
- Pain relief for mulesing: Tri-solfen®
- Treatment for breech flystrike: Chemical treatment with Extinosad® Eliminator (25g/L Spinosad), trim wool
- Additional prevention of breech flystrike in non-mulesed flocks, including:
    - Additional chemical use: 1 additional treatment with Cyromazine jet or dip (500 g/L)
    - Additional crutchings: Nil

The full model output regarding transitioning to a non-mulesed Prime Lamb enterprise in a summer-dominant rainfall area is contained in the appendices under section 10.2.5. Table 11 shows the overall net present value calculation for a Prime Lamb enterprise in a summer dominant rainfall area transitioning to a non-mulesed flock across the 7-year phase out period. There is a NPV of $3,647 over the entire flock, or $0.33 per DSE associated with this change. Some caution should also be exercised given the relatively small sample size of survey respondents that may not reflect long term industry outcomes, and the lower incidence of breech flystrike reported from non-mulesing survey respondents compared to mulesing respondents in Prime Lamb flocks in summer-dominant rainfall areas. As for the Prime Lamb enterprise models for winter-dominant and uniform rainfall areas, it is highly likely that the reduced incidence of breech flystrike in non-mulesing Prime Lamb producers is due to either a small sample size, variation in management practices, genetics or other factors from survey respondents. However, it does indicate that Prime Lamb producers in summer-dominant rainfall regions of Australia should not experience substantial costs when transitioning to a non-mulesing enterprise.

However, if breech flystrike control is not properly implemented in flocks transitioning to non-mulesed, the impact of not mulesing on breech flystrike prevalence may be higher than that observed in survey respondents. Furthermore, the difference in cost will be smaller if non-mulesed flocks continue to use

pain relief for castration and tail docking at marking. It ought to be noted that there are no fleece or stock sale premiums included in this analysis, when in reality there may be a premium on the price of with non-mulesed wool if farms are certified with some programs, and this is likely to lead to further financial benefits.

Table 11. Summary of net present value for transitioning to a non-mulesed Prime Lamb enterprise in a summer-dominant rainfall area over 7 years.

	NPV
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing	$3,647
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing (per DSE)	$0.33

3.3.6 Merino, Summer-Dominant Rainfall

Based on survey respondents from Milestone 1 of this project, further assumptions for summer-dominant rainfall Merino enterprises (in addition to those outlined above), include:

- Breech flystrike rates of 4.0% for Merino producers' mulesing in summer-dominant rainfall areas.
- Breech flystrike rates of 0.5% for non-mulesing Merino producers' in summer-dominant rainfall areas.
- Non-mulesed wool premium/discount: 2%
- Non-mulesed stock sale premium/discount: 0%
- An average dag score of 3 (out of 5) in mid-spring for non-mulesing Merino enterprises, compared to an average dag score of 1 for mulesing enterprises.
- Increased inspection frequency for non-mulesed stock (weekly): +1
- Pain relief for mulesing: Tri-solfen® and Buccalgesic
- Treatment for breech flystrike: Chemical treatment with Extinosad® Eliminator (25g/L Spinosad), trim wool
- Additional prevention of breech flystrike in non-mulesed stock, including:
    - Additional chemical use: 1 additional treatment of Coopers Blowfly and Lice® (Ivermectin 16 g/L)
    - Additional crutchings: 1 additional crutching (ewes, wethers and rams only)

The full model output regarding transitioning to a non-mulesed Merino enterprise in a summer-dominant rainfall area is contained in the appendices under section 10.2.6. The findings shown in Table 12 indicates that where the initial non-mulesed wool premium of 2% is phased out over the 7-year period, then it is estimated that phasing out of mulesing will cost a producer with a 3,000 ewe self-replacing Merino flock approximately $67,403, or $7.22 per DSE. Where the 2% wool premium is not phased-out over the 7-year transition period to non-mulesing Table 13, then it is anticipated that the cost of transitioning to non-mulesing will reduce to $39,747 for a 3,000 ewe self-replacing Merino flock, or $4.26 per DSE.

Based on the survey results from Milestone 1, mulesed Merinos had a higher breech flystrike percentage than non-mulesed Merinos. As for the Merino enterprise model for uniform rainfall areas, it is highly likely that the reduced incidence of breech flystrike in non-mulesing Merino producers is due to either a small sample size, variation in management practices, genetics or other factors from survey respondents. Similar to the Merino enterprise model for uniform rainfall, it does indicate that the cost due to a higher dag score in the unmulesed group outweighed the total change in breech flystrike treatment costs and wool loss.

Table 12. Summary of net present value for transitioning to a non-mulesed Merino enterprise in a summer-dominant rainfall area over 7 years. For this table, there has been a staged phase-out of the initial 2% non-mulesed wool premium over the 7-year period.

	NPV
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing	-$67,403
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing (per DSE)	-$7.22

Table 13. Summary of net present value for transitioning to a non-mulesed Merino enterprise in a summer-dominant rainfall area over 7 years. The output in this table assumes that the initial 2% non-mulesed wool premium remains over the 7-year period and is not phased out as in Table 12

	NPV
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing	-$39,747
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing (per DSE)	-$4.26

NOTE: It was surprising that the dag scores of Merino sheep in winter- and summer-dominant and uniform rainfall areas were the same in the survey responses. It would be expected that the dag score of Merinos in winter-dominant rainfall areas would be higher.

3.4 Scenarios run using breech strike prevalence from other literature (as requested by MLA)

The cost: benefit model was also used to analyse scenarios using alternative breech strike prevalence found in existing literature.

Prime Lamb enterprises

3.4.1 Prime Lamb, Winter-Dominant rainfall

There were no robust data sources available which described the prevalence of breech flystrike in Prime Lamb flocks in summer or uniform rainfall areas. The prevalence for breech flystrike in Prime Lamb flocks

in winter rainfall areas were taken from Reid & Jones (1976), who compared breech flystrike and dag in non-mulesed Corriedales or crossbred (Border Leicester x Corriedale) ewes, to ewes of each type that had had either a modified or radical mules treatment, in Cressy, Tasmania. Three cohorts of ewe lambs (1971, 1972 and 1973 drop) were followed for 20 months after allocation to group and treatment at marking, and their breech flystrike recorded. Importantly, no preventative chemical treatment was applied to either group, and strikes were treated with diazinon. The mean breech flystrike prevalence over the 20-month period for the three cohorts; and the annualised mean, are shown below in Table 14. The analysis was conducted on the annualised mean, however another analysis was also conducted with the annualised mean for each group halved, to account for the lack of preventative chemical treatment, which is not likely to occur under present day management systems. The breech flystrike prevalence in the control group was compared to that of the Radical mules group, as that was considered to be the one most similar to the most common current mulesing technique.

Table 14. Breech flystrike prevalence (%) over 20 months, and annualised, in Corriedales and Crossbred ewes (from Reid & Jones, 1976)

Treatment	Corriedale					Crossbred				
	1971	1972	1973	Mean	Annualised mean	1971	1972	1973	Mean	Annualised mean
Radical mules	2.9	5.7	2.9	3.83	2.3	0	2.9	0	0.97	0.58
Modified mules	17.1	34.3	5.7	19.0	11.4	8.6	2.9	2.9	4.8	2.9
Control	85.7	57.1	40.0	60.9	36.5	22.9	31.4	37.1	30.5	18.3

The full model output regarding transitioning to non-mulesed flocks in Corriedale and Crossbred enterprises in a winter-dominant rainfall area, using the breech flystrike prevalences from Reid & Jones (1976) is contained in the appendices under sections 10.3.1 and 10.3.2 for Corriedales and Crossbreds, respectively. No preventative chemical treatment was included in the analysis, and the difference in average dag score between mulesed and unmulesed (1 score) was kept the same as the other scenarios. Analysis showed a very substantial negative cash flow of -$452,570.13 across the flock of 3000 ewes, or -$41.06 per DSE in Corriedales (Table 15), and a -$227,140.81 across the flock, or -$20.61 per DSE in crossbreds (Table 16), across the 7-year phase out period. If the breech flystrike prevalence was halved, the NPV is -$19.84 per DSE in Corriedales, and -$9.61 in Crossbreds.

The NPV is much lower than that modelled using the survey data, owing to the large annualised breech flystrike prevalence in non-mulesed sheep compared to the survey responses (average of 37% across the three years of the study in Corriedales, and 18% in the Crossbred ewes), compared to 3% prevalence in mulesed flocks and 0.5% in non-mulesed flocks in winter rainfall areas in the survey. The prevalence of breech flystrike observed in the Reid and Jones (1976) trial is less likely to occur in non-mulesed sheep in modern flocks with proactive breech flystrike preventative programs (chemical control and crutching). However, it does illustrate that there is the potential for very large outbreaks of breech flystrike if sheep are not monitored closely and managed pro-actively, especially in wet seasons when chemical control periods will be shortened. Furthermore, increased use of chemical may hasten resistance over time and diminish effective control.

Table 15. Summary of net present value for transitioning to a non-mulesed Prime Lamb flock in a summer-dominant rainfall area over 7 years, using Reid & Jones (1976) breech flystrike prevalence for Corriedales.

	NPV	NPV with half strike
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing	-$452,570	-$218,659
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing (per DSE)	-$41.06	-$19.84

Table 16. Summary of net present value for transitioning to a non-mulesed Prime Lamb flock in a summer-dominant rainfall area over 7 years, using Reid & Jones (1976) breech flystrike prevalence for Crossbred ewes.

	NPV	NPV with half strike
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing	-$227,140	-$105,945
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing (per DSE)	-$20.61	-$9.61

Merino Enterprises

Based on the methodology and results in the thesis by Tyrell (2013), further scenarios were modelled for Merino enterprises in both winter-dominant and uniform rainfall regions. Also modelled were two separate periods, one from spring through to early summer (Period 1), when the sheep were within the protection period of Cyromazine, and a second period from late summer through to autumn (Period 2), when the protection period of Cyromazine had expired or the sheep had been crutched. Even though sheep had been crutched, protection against breech flystrike may only last for up to 2 weeks in non-mulesed Merinos (Watts *et al* 1979) and 8 weeks in mulesed Merinos (Raadsma 1988).

3.4.2 Merino, Winter-Dominant Rainfall

The following are additional assumptions for winter-dominant rainfall Merino enterprises and include:

- Breech flystrike rates for Merino producers' mulesing in winter-dominant rainfall areas over two periods:
  - Period 1: 2.2%
  - Period 2: 0.0%

- Breech flystrike rates for non-mulesing Merino producers' in winter-dominant rainfall areas of:
  - Period 1: 0%
  - Period 2: 0.7%

- Additional prevention of breech flystrike in non-mulesed stock, including:

    - Additional crutching: Nil

- Average dag score of non-mulesing Merino enterprises:
    - Period 1: 3 (out of 5)
    - Period 2: 2

- Average dag score of mulesing Merino enterprises:
    - Period 1: 2
    - Period 2: 1

The full model output regarding transitioning to non-mulesing for a Merino enterprise in a winter-dominant rainfall area for Period 1 and Period 2 are contained in the appendices under section 10.3.3. and 10.3.4, respectively. When using Tyrell (2013) breech flystrike rates and dag scores from Period 1, there is a positive cash flow of $18,766 or $2.01 per DSE when the 6.6% non-mulesed wool premium is phased out over a 7-year period (Table 17), or $110,032 (or $11.78 per DSE) if the premium remains over the 7-year period .

In comparison to the results from the scenarios modelled using survey responses from producers of Merino enterprises in winter-dominant rainfall areas (**Error! Reference source not found.** and**Error! Reference source not found.**), there is a significant improvement in cash flow when transitioning to a non-mulesed enterprise. This is a reflection of the higher breech flystrike rate in mulesed Merinos vs non-mulesed, taken from Tyrell (2013), whereas compared to that reported in the surveys, non-mulesed had a higher breech flystrike percentage (1.1%) than mulesed Merinos (0.6%). Additionally, there was no extra crutching in Tyrell (2013) study, however crutching was an extra cost that was used in the previous Merino model using assumptions taken from the survey responses in winter-dominant rainfall areas. Due to the increased likelihood of dag accumulation on non-mulesed Merinos in winter-dominant rainfall areas, it is likely that an extra crutch will be required for non-mulesed Merinos.

Table 17. Summary of net present value for transitioning to a non-mulesed Merino enterprise in a winter-dominant rainfall area over 7 years. For this table, there has been a staged phase-out of the initial 6.6% non-mulesed wool premium over the 7-year period, using Tyrell (2013) strike prevalence and dag score results for Period 1 when the non-mulesed sheep were within the protection period of Cyromazine (Period 1).

	NPV
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing	$18,766
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing (per DSE)	$2.01

Table 18. Summary of net present value for transitioning to a non-mulesed Merino enterprise in a winter-dominant rainfall area over 7 years. The output in this table assumes that the initial 6.6% non-mulesed wool premium remains over the 7-year period and is not phased out as in Table 17, using Tyrell (2013) strike prevalence and dag score results for the period from spring through to early summer when the non-mulesed sheep were within the protection period of Cyromazine (Period 1)

	NPV
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing	$110,032
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing (per DSE)	$11.78

If using the breech flystrike rates reported during Period 2, it was estimated that over a 7-year period, a producer with a 3,000 ewe self-replacing flock of approximately would have a slight increase in cash flow of approximately $8,274 or $0.89 per DSE if the initial 6.6% premium for non-mulesed wool is phased out over this 7-year period (Table 19). The previous scenario using survey responses from Merino producers in winter-dominant rainfall areas (**Error! Reference source not found.**) indicated a cost of $76,499 or $8.19 per DSE. The extra costs in the Merino model using the survey responses was due to an extra crutching, and also a 2 score difference between dag score of the non-mulesed and mulesed groups.

If the 6.6% premium for non-mulesing wool remained over the 7-year phase out period, Merino enterprises transitioning to a non-mulesed enterprise would see an increase in cash flow of $99,539 or $10.66 per DSE (

Table **20**).

Table 19. Summary of net present value for transitioning to a non-mulesed Merino enterprise in a winter-dominant rainfall area over 7 years. For this table, there has been a staged phase-out of the initial 6.6% non-mulesed wool premium over the 7-year period, using Tyrell (2013) strike prevalence and dag score results for the period from summer-autumn when the protection period of the non-mulesed sheep had expired (Period 2)

	NPV
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing	$8,274
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing (per DSE)	$0.89

Table 20. Summary of net present value for transitioning to a non-mulesed Merino enterprise in a winter-dominant rainfall area over 7 years. The output in this table assumes that the initial 6.6% non-mulesed wool premium remains over the 7-year period and is not phased out as in Table 19, using Tyrell (2013) strike prevalence and dag score results for the period from summer-autumn when the protection period of the non-mulesed sheep had expired (Period 2)

	NPV
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing	$99,539
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing (per DSE)	$10.66

3.4.3 Merino, Uniform Rainfall

Based on the methodology and results in the thesis by Tyrell (2013), the following assumptions for uniform rainfall Merino enterprises, include:

- Breech flystrike rates for Merino producers' mulesing in winter-dominant rainfall areas over two periods:
  - Period 1: 2.5%
  - Period 2: 1.3%

- Breech flystrike rates for non-mulesing Merino producers' in winter-dominant rainfall areas of:
  - Period 1: 0.8%
  - Period 2: 14.9%

- Additional prevention of breech flystrike in non-mulesed stock, including:
  - Additional crutching: Nil

- Average dag score of non-mulesing Merino enterprises:
  - Period 1: 4 (out of 5)
  - Period 2: 3

- Average dag score of mulesing Merino enterprises:
  - Period 1: 3
  - Period 2: 2

NOTE: The data used here from Tyrell (2013) was taken from Gippsland which would have more dag than would be expected in uniform rainfall areas throughout NSW, due to *Trichostrongylus vitrinus* being more dominant in Gippsland, a major cause of scour and hence dag accumulation in Merinos.

The full model output regarding transitioning to non-mulesing for a Merino enterprise in a uniform rainfall area for Period 1 and Period 2 are contained in the appendices under section 10.3.5 and 10.3.6. Based on Tyrell (2013) results and using no non-mulesed wool premium, Table 21 and Table **22** show that phasing out mulesing for Merino producers in uniform rainfall areas will cost between an estimated $34,653 or $205,826 depending on which breech flystrike rates are used for the non-mulesed enterprises.

This highlights that not only is extra chemical control and crutching a contributor to the cost of transitioning to a non-mulesed flock, but also the cost of dags. If it is a high-risk year for flystrike, the cost of transitioning to a non-mulesed flock will be extremely high if breech flystrike is not well controlled. This is due to increased prevalence and associated production losses associated with breech flystrike in non-mulesed Merinos (**Table 12**Table 22).

Table 21. Summary of net present value for transitioning to a non-mulesed Merino enterprise in a uniform rainfall area over 7 years, using Tyrell (2013) strike prevalence and dag score results for the period from spring through to early summer when the non-mulesed sheep were within the protection period of Cyromazine (Period

1). Note that no wool or stock premium has been applied to the outputs for this model, and as a result there is no effect of phasing out of premiums across the 7-year period.

	NPV
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing	-$34,653
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing (per DSE)	-$3.71

Table 22. Summary of net present value for transitioning to a non-mulesed Merino enterprise in a uniform rainfall area over 7 years, using Tyrell (2013) strike prevalence and dag score results for the period from summer-autumn when the protection period of the non-mulesed sheep had expired (Period 2). Note that no wool or stock premium has been applied to the outputs for this model, and as a result there is no effect of phasing out of premiums across the 7-year period.

	NPV
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing	-$205,826
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing (per DSE)	-$22.04

3.5 Inclusion of sale weight impact of mulesing in the cost: benefit model (as requested by MLA)

A separate section of the impact of mulesing on sale weight of lambs was included in the "Model Assumptions" tab in the cost: benefit model (see excel spreadsheet sent separately to this document). This was developed to analyse the likely implications of mulesing on sale weight of weaners. As for the previous model, the structure of this analysis allows producers to populate the spreadsheet with their own, personalised data on lamb liveweight in a mulesed operation, and price received.

Part 1 of the analysis, implications of mulesing on weaner sale weight, looks at lamb bodyweight at 4.5 to 5 months of age. Note that there has been found to be no reduction in bodyweight of mulesed lambs, compared to unmulesed, from six months of age onwards. This scenario assumes that lambs of this age are sold directly to slaughter, which is very uncommon for Merino lambs especially in high rainfall regions. Generally, first cross ewe lambs and all Merino lambs are more likely to be mulesed, as compared to Prime lambs. It is rare to mules terminal meat lambs that are intended to be sold at less than one year of age, so valuing any penalty of mulesing where the impact is only likely to occur at less than 6 months of age should be treated with caution.

To obtain the assumptions used in part 1, figures from two different studies, which compared liveweight of mulesed and non-mulesed Merinos, were used. The study by Evans et al (2012) compared bodyweights of mulesed, unmulesed and clipped Merino lambs, and found that mulesed lambs were 3% lighter than non-mulesed lambs 90 days after marking. Tyrell (2013) compared mulesed and unmulesed

lambs on three farms over 2 years and showed a significant difference on 2 of 6 occasions; the greatest difference (5% liveweight; at 120 days post marking) was used in this cost: benefit analysis to demonstrate the largest reduction in lamb bodyweight likely based on the results of that study. Using these figures, a 30kg non-mulesed lamb would generate $3.53 (3% increase in liveweight; Evans et al (2012) and $5.88 (5% increase in liveweight; Tyrell (2013) increased income, respectively.

It should be noted that pain relief was not administered to lambs in either of these studies; pain relief for mulesing is now mandatory in Victoria and strongly recommended in other states of Australia; though pain relief has not been shown to have any effect on subsequent weight gain. Furthermore, Lightfoot & McGarry (1964) found that non-mulesed lambs which did not receive flystrike prevention were more likely to be struck than their mulesed counterparts, resulting in decreased weight gain in the non-mulesed group. The weight gain penalty was likely associated with flystrike rather than a penalty associated with any surgical intervention.

Part 2 of the analysis, implications of mulesing on weaner sale weight, looks at the effect on returns if lambs are sold store or for finishing, but also gives an option to allow for a per head premium for mulesed lambs, which anecdotally is typically between 5 to 10%. Evans et al (2012), found that mulesed lambs were 5% lighter than non-mulesed lambs 50 days after marking, when such lambs would likely to be sold. Assuming a 5% per head premium on mulesed lambs, the sale price of unmulesed lambs is 0 to 2% higher (using Tyrell and Evans et al figures, respectively). If the non-mulesed lambs are heavier, it will erode the premium received for mulesed lambs, as shown by Tyrell (2013) data.

3.5 Take-home message

Findings from these case scenarios indicated a positive cash flow (ranging from $0.33 to $2.19 per DSE, depending on rainfall areas) for Prime lamb enterprises transitioning to non-mulesing compared to continuing mulesing. Note that based on survey responses, there were no fleece or stock sale premiums included in these analyses. So, there may be an opportunity for Prime Lamb producers to receive a premium on the price of non-mulesed wool if farms are certified with some programs, and this would lead to additional financial benefits. For Merino enterprises, the case scenarios modelled indicated a positive cash flow of $1.58 per DSE in winter rainfall areas (assuming a 6.6% wool premium over a 7-year period), and a negative cash flow of $-4.29 to $-9.08 per DSE in summer and uniform rainfall areas, respectively. Note that based on survey responses, a 2% wool premium was applied to the scenario in summer rainfall zones, but no wool premium was applied to the model in uniform rainfall areas. Overall, results from the scenarios indicated that there is little cost to be incurred for Prime Lamb producers to shift to non-mulesing operations. In contrast, Merino producers will incur the highest costs of phasing out of mulesing.

In both Prime Lamb and Merino enterprises, the extra chemical control is a contributor to the cost of transitioning to a non-mulesed flock. In a Merino enterprise transitioning to a non-mulesed enterprise, crutching is also a contributor to the cost, however the major contributor is dags, due to an increase loss of wool from dags and a larger crutch area. If it is a high-risk year for flystrike, the cost of transitioning to a non-mulesed flock will be high if breech flystrike is not well controlled. This is due to increased prevalence and associated production losses associated with breech flystrike in non-mulesed Merinos and Prime Lamb enterprises.

Due to the high degree of variability in survey respondents and producers deemed as “Prime Lamb” producers (from terminal meat breeds to Merino enterprises), the cost: benefit analysis was developed as a producer “tool”. This allows producers to populate the spreadsheet with their own, personalised data, or, in the instance where this is not available, enterprise- and rainfall-specific data is utilised in its stead. The research team felt that due to the variability in producer respondents and enterprises across Australia that a producer tool was more appropriate, allowing a cost-benefit analysis to be completed to a specific enterprise type and operation.

4. The New Zealand experience with the cessation of mulesing

4.1 Methodology

For this component of the project, a literature review, and a series of interviews with New Zealand’s stakeholders were conducted. A total of 15 stakeholders were interviewed by either email, phone, or in-person to obtain their opinions and views about the ban of the mulesing procedure in New Zealand. Stakeholders represented animal welfare organizations, university/research organisations, industry representatives, and flock veterinarians. A series of open-ended questions were used for the interviews, with key questions including: “What was the situation before phasing out mulesing? (e.g., prevalence of the practice, producer attitudes)”, “How was phasing out of mulesing conducted?”, “Was any cost-benefit analyses performed to inform the decision?” and “What was the response of the different stakeholders to phasing out mulesing?”

4.2 Key findings

4.2.1 Overview of the New Zealand sheep industry

Similar to the Australian sheep industry, the New Zealand farming system is extensive in nature. Sheep are housed outdoors all year round, usually with limited monitoring and minimal supplementary feed compared to more intensive, lot-fed based systems (Morris, 2017). There are few farms that only farm sheep or beef, with most producers farming sheep and cattle together in either hill country or flat grasslands. Sheep production in New Zealand is an important economic activity and forms a large part of their national branding and image. New Zealand is the world’s third-largest wool producer, producing 12% of total international production. The predominant breeds of sheep are the Romney or their crossbred derivatives (Morris, 2017). As a result, approximately 90% of wool produced in New Zealand is classified as strong crossbred wool (i.e. greater than 31 microns) rather than fine wool (Beef+Lamb New Zealand, 2018). The majority of this wool is sold into the Chinese market. Currently, fine wool Merinos only represent around 2 to 5% of sheep numbers. The New Zealand Merino flock is predominantly farmed in the South Island by around 700 farmers, with flock sizes of 1,000 – 2,000 breeding ewes (Beef+Lamb New Zealand, 2018; Dymock & Forgie, 1995).

4.2.2 Prevalence and risk of flystrike in New Zealand

Since the early 1900s, flystrike (including breech flystrike) has been recognised as a serious issue to New Zealand sheep farmers (Gleeson & Heath, 1997; Morris, 2003). Four blowfly species cause flystrikes in the country. In order of prevalence, they are; the Australian green blowfly (*Lucilia cuprina*), the European green blowfly (*Lucilia sericata*), the Brown blowfly (*Calliphora stygia*) and the Hairy maggot blowfly (*Chrysomya rufifacies*) (Heath, 1994; Heath & Bishop, 2006; Sandeman et al., 2014). While there are limited studies on flystrike prevalence, it has been estimated that about 3 to 5% of the national flock is affected annually (Heath, 1994; Heath & Bishop, 2006). Flystrike is considered to be more common and more severe in the North Island due to the warmer weather and higher humidity relative to the South Island. This is particularly evident in the areas of Gisborne, Wanganui and Waikato. However, while less severe and with a shorter season, flystrike can also be found in the South Island, particularly in Canterbury and Marlborough (Heath & Bishop, 2006).

Flystrike affects all breeds of sheep in New Zealand. The most commonly affected breeds are Romney and Romney crosses while Merino and Merino crosses only account for 8.2% of the cases (Heath & Bishop, 2006). However, this is likely due to the small numbers of Merinos in the country rather than a breed-flystrike correlation (Heath & Bishop, 2006; Horton et al., 2018). Female sheep and lambs are the most common combination of sex and age groups affected. Breech flystrike is the predominant presentation, accounting for up to 90% of flystrike cases (Heath & Bishop, 2006).

4.2.3 Phasing out mulesing in New Zealand

In 2004, the wool industry was challenged by the international animal rights group People for the Ethical Treatment of Animals (PETA) who called for a boycott of Australian wool products until the practice of mulesing was stopped. The New Zealand wool industry, in response to animal welfare concerns and market pressure, rapidly began a plan to phase out mulesing. The Merino New Zealand Company, a for-profit wool broker that carries about 75% of the total market share of merino wool was a key player by adopting a voluntary ban on surgical mulesing by December 2010. There were some marketing efforts by companies such as Merino New Zealand to position the New Zealand sheep industry as leaders in animal welfare. As a result, it was concluded that mulesing was not compatible with their stance as leaders in animal welfare and must be phased out. Although it needs to be considered that not all industry leaders in New Zealand were headed in this direction.

The New Zealand Merino industry largely ceased mulesing in 2010 by using four key strategies:

1. Participation of key stakeholders (brands and proactive woolgrowers)
2. Market-based incentives to phase out mulesing
3. Research and extension program (exposing farmers to science-backed strategies to decrease the risk of flystrike)
4. The development of a certification scheme

Overall, the approach of the industry was to eradicate mulesing by offering extra support and economic incentives to producers that decided not to mules their sheep rather than directly advocating for cessation of mulesing.

The New Zealand process of phasing out mulesing started with gathering information about common practices used to prevent flystrike and producer perspectives on mulesing. An important finding was that, although the procedure was adopted in New Zealand, the prevailing attitude towards mulesing by producers tended to be negative. *"the attitude was that it was an Australian thing that had no place in New Zealand sheep farming"* and "*the feeling was that most farmers were looking for an excuse not to mules"*. It is possible that these attitudes facilitated, to some extent, the phasing out of the practice.

Participation of key stakeholders and market-based incentives to phase out mulesing

An important factor that motivated producers to phase out mulesing was market pressure, as it was difficult to sell fine wool from mulesed sheep at good prices. Market premiums and forward contracts were an important driver for producers. The involvement of the domestic and international market was an important step in the process of phasing out mulesing in New Zealand. These forward contracts enabled the industry to secure minimum and maximum prices to guarantee profitability to both wool growers and retailers. "*Forward contracts were a big underlying pillar of the change, contracts provided certainty that there was a future", "Brands were actually approaching the industry saying what can we do to help decrease this practice that we see a problem with"* and "*Icebreaker started direct contracts with the leading growers, they gave growers 2-year contracts that locked in minimum prices that guaranteed them profitability. At the time it was revolutionary and a real win/win breakthrough*"(report by Hartford, 2005). The dominance of the New Zealand Merino Company as a buyer of approximately 75% of the total New Zealand Merino wool clip and their stance towards mulesing was a key factor in phasing out of mulesing in New Zealand.

Another very important strategy taken by the industry was to engage with proactive woolgrowers from the beginning of the phasing out strategy. Woolgrowers that phased out mulesing were encouraged to talk to other farmers, share their experiences and motivate others to phase out the practice too. They became important influencers.

Research and extension program

The next step was to develop an extension program encouraging the adoption of non-mulesed systems. There was no clear strategy on how mulesing should be phased out. This allowed producers to customise a strategy for each property accounting for their type of sheep, management practices, labour, extra costs associated, etc. It is important to recognise that no formal cost-benefit analysis was conducted to inform the phasing out strategy. While there was no "one-size fits all" approach, the main focus of the extension program was on targeted chemical use and implementation of breeding programs selecting for Merinos which did not require mulesing. The use of long-acting chemicals such as Dicyclanil was encouraged. *"A lot of it was the advent of long-acting chemicals that allowed the change [to non-mulesing] to take place. Being able to protect lambs [against breech flystrike] from tailing to weaning with one application allowed farmers to change".* Research conducted at the time on genetic heritability of breech traits (Scobie et al., 2011; Scobie et al., 2012) also helped to further inform the extension program. These studies showed that selecting for low wrinkle, dag and urine stain scores, and bare breech helped to identify sheep less prone to breech flystrike. These findings were presented to farmers in a series of on-farm workshops to facilitate knowledge transfer. *"We were able to show that scoring for the 2-3 traits was a good means of identifying those animals more prone to flystrike and that ram selection could be effectively used to reduce the need to Mules. At the end of the study, we did a roadshow discussing our findings which was I think well accepted"*.

The opportunity to communicate and discuss alternatives to mulesing with other producers was one of the key components that helped with the success of the strategy. This approach allowed for clarifications about feasible alternatives and probably improved trust. *"This [on-farm workshops approach] proved some of the big questions producers had over stopping mulesing incorrect".* Overall, the main strategies adopted by woolgrowers were, in order of preference: more reliance on long-acting chemicals, more frequent shearing and crutching, parasite control, monitoring and breeding sheep with less wrinkles in the breech area.

The development of a certification scheme

At the same time the extension program was developed, the New Zealand Merino Company established the Zque™ certification scheme to ensure retailers and consumers that the wool was being sourced from non-mulesed operations. The certification scheme consisted of random inspections, with one inspection undertaken every 3 years conducted by a trained and accredited veterinarian. To this date, all growers which are part of the New Zealand Merino Company continue to be audited (around 500-600 out of 700 woolgrowers). The audits cover a wide range of aspects on the farm, including mulesing. Auditors must assess the youngest class of stock for any evidence of mulesing scars.

Stakeholders' response towards phasing out mulesing

The response towards phasing out mulesing varied between producers. While proactive farmers were quickly on board, some woolgrowers were reluctant to change. Producers that had negative experiences with breech flystrike were particularly unwilling to phase out mulesing because they considered mulesing as the most effective method to prevent breech flystrike. The New Zealand Merino Company did acknowledge that they lost some business initially as a result of their stance on mulesing, due to some growers wanting to maintain the ability to mules due to high perceived risk of breech flystrike in non-mulesed Merinos. "*Producers that experienced strike historically were emotionally scarred"*. Some woolgrowers lobbied to keep the practice. However, given the small population of fine woolgrowers in New Zealand relative to Australia, they did not obtain the support of the wider New Zealand sheep industry.

Another factor that facilitated the transition was that mulesing contractors were mostly from Australia. Thus, once the industry decided to voluntary phase out the procedure the operators stopped travelling to New Zealand.

Legislation

The New Zealand industry largely achieved its aim of phasing out mulesing by 2010. In 2017, the National Animal Welfare Advisory Committee (NAWAC) undertook a public consultation to ban mulesing and the outcomes were vastly supportive of a total ban. In 2018, after public consultation, the regulations put in place a prohibition of all forms of mulesing. It was considered that alternative less invasive methods were available to manage flystrike and that these were already being successfully used in New Zealand. Some relevant quotes included "*We are unaware of anybody undertaking mulesing in NZ in recent history, especially since the voluntary moratorium was introduced in 2010"* and *"By the time the legislation hit, there would be almost nobody using the procedure".* According to the New Zealand Code of Welfare for sheep, a person must not, by any method, remove the breech, tail skin folds, or tail skin wrinkles of a sheep. A person who fails to comply with this subclause commits an offence and is liable on conviction, in the case of an individual, to a fine not exceeding NZD $5,000; or in the case of a body corporate, to a fine not exceeding NZD $25,000 (Ministry for Primary Industries, 2018). Currently, on-farm audits performed

by the New Zealand Merino Company and inspections at the abattoirs are the main instruments to monitor compliance with regulations. To date, no cases of non-compliance have been reported.

A summary of the New Zealand strategy to phase out mulesing is presented below in figure 1.

Fig 1. The New Zealand strategy to phase out mulesing

4.3 Take-home message

It took about 5 years to phase out mulesing in New Zealand and this effort was largely industry-led. The industry achieved its aim in 2010 by using four key strategies (1) participation of key stakeholders, (2) market-based incentive to phase out mulesing (e.i. forward contracts), (3) by developing a research and extension program (exposing farmers to science-based strategies to decrease the risk of flystrike) and (4) by developing a certification scheme. The approach of the industry was not to advocate for ceasing mulesing but offering extra support and economic incentives to producers that decided not to mules their sheep. It should be acknowledged that due to the New Zealand Merino Company having approximately 75% market-share of wool purchased in New Zealand, their advocacy for ceasing mulesing was a key factor contributing to the phasing out of mulesing. This is different to the Australian situation, where there is (1) a larger Merino population and (2) a substantially higher number of wool buyers than in New Zealand. As a result, market share of individual wool buyers is substantially lower than that of the

New Zealand Merino Company. While New Zealand has a much different wool industry, climate, different sheep and size of enterprises than Australia, the challenge of having a sustainable industry that can meet consumers' demands is not significantly different, and a number of lessons can be learned from their experience. After reviewing the New Zealand experience, the key take-home messages are that (1) the industry needs to be proactive, and a collaborative approach must be taken including the industry, market and producers (2) financial benefits are a key driver to phase out mulesing, and this can be supported by the development of a industry certification scheme, and, (3) on-farm programs exposing farmers to science-based strategies are essential as well as giving producers the opportunity to share and discuss their ideas and experiences.

5. Pathways and barriers to adoption

5.1 Methodology

To achieve the aim of this component, we conducted a focus group (n=13 participants), phone interviews with producers (n=20), phone interviews with shearers (n=11) and a national producer survey (n=546). Key aspects investigated included: attitudes, trust and perceived barriers to behavioural change. Data on sources of knowledge e.g., whom farmers rely on for advice were also collected. Details of the methodology for this component is presented below.

Focus group

The focus group conducted in this project was facilitated by Professor Grahame Coleman, a psychologist, part of the research team, with more than 30 years of experience conducting qualitative research in the livestock sector. The focus group began with a short introduction and broad explanation of the project. The facilitator asked a series of questions using a semi-structured agenda pertaining to flystrike risk and flystrike prevention strategies (Appendix 10.4). The questions were developed based on the Theory of Planned Behaviour (Ajzen & Fishbein, 1980), thus, aimed to identify the perceived importance of mulesing (behavioural beliefs), sources of trust and advice (normative beliefs) and the ease or difficulty of phasing out mulesing (control beliefs). Participants were encouraged to discuss their opinions in an informal manner and had the opportunity to raise other related topics outside the semi-structured agenda. The facilitator ensured that all participants engaged in conversation and maintained the direction of the conversation by guiding topics back to relevance when necessary. The focus group ran for about 90 minutes and was audio-recorded. Thematic analysis was used to analyse the focus group transcript. Topics discussed by participants during the discussions were classified into primary and secondary themes using the Nvivo software.

Phone interviews with producers

In response to the COVID-19 restrictions, the remaining focus groups that were planned for this component of the project were cancelled and a series of one-on-one phone interviews were conducted instead. This allowed a further understanding of farmers' salient behavioural, normative and control beliefs about mulesing and salient beliefs about adopting alternative breech strike prevention methods. Snowball recruitment was used to recruit producers for the interviews using the Mackinnon and the Animal Welfare Science Centre's established networks. The questions asked during the phone interviews

were based on the focus group agenda. Key questions asked to producers were in relation to the importance/effectiveness of mulesing, the influence of others in the decision to mules or stop having mulesed sheep and barriers to adopt alternatives to mulesing. The interviews ranged from 60 to 90 minutes in duration and were audio recorded. All interviews were transcribed and analysed according to the main topics/themes discussed. The analyses were conducted using the Nvivo software for qualitative data.

Phone interviews with shearers

The focus group results highlighted the role of different stakeholders in the continuation of mulesing. For instance, it was raised during the discussions that some farmers were willing to pay more for mulesed sheep, breeders and stock agents receive economic benefits and shearers prefer mulesed over unmulesed sheep. Considering these results, we conducted a series of one-on-one interviews with shearers. The aim of conducting these interviews was to investigate shearer attitudes, beliefs and experiences regarding mulesed and non-mulesed sheep and how it impacts the ease of shearing. Snowball recruitment was used to recruit shearers for the interviews using previous producer interview participants' recommendations, the animal welfare science centre's established networks and industry network coordinators. At the end of each interview, participants were asked if any other shearers they knew might be interested in an interview on the same topic. Semi-structured in-depth telephone interviews were conducted, and included questions around individuals' attitudes, opinions and experiences related to the impact of mulesing and the length of a sheep's tail on their shearing practice. Follow-up questions enabled more detailed explanations to be elicited. The interviews ranged from 20-60 minutes in length and were audio recorded. The interviews were transcribed verbatim. Key questions asked to shearers in relation to mulesing included:

Shearers' attitudes and experiences regarding mulesed and non-mulesed sheep

- What makes shearing easier/ difficult?
- What makes crutching easier/difficult?
- What do you think about mulesing? Are you in favour or not? Why?
- How does mulesing impact shearing for you?
- Have there been times where you've requested a higher pay rate? What was the reason for this?
- Have you ever talked to your contractor or the farmer about their sheep e.g., about whether they were mulesed or not?
- Do you think mulesing is common in the sheepmeat industry?
- What do you think about banning mulesing in the sheepmeat industry? Do you think other shearers would think the same?
- Have you worked overseas as a shearer? What do you think about NZ banning mulesing?
- Other comments

Attitudinal Survey

Surveys are considered an appropriate research approach to gathering qualitative information on the opinions of people (Ajzen & Fishbein, 1980). Therefore, a national attitudinal survey was conducted to further identify relationships between farmers' behaviour (running mulesed or non-mulesed enterprises) and farmers' attitudes. This survey aimed to collect qualitative and quantitative information on farmer

attitudes, beliefs and perceived barriers towards ceasing mulesing, with particular emphasis in the sheepmeat industry.

Survey development

The survey was developed using an iterative process. The first draft of the survey was developed based on previous questionnaires that had been developed by the Animal Welfare Science Centre for a range of livestock industries including the pork and red meat industries. In addition, the results obtained from the focus group, the one-on-one phone interviews and the cost-benefit survey were used to refine the attitudinal survey. The main areas included in the survey were behaviour, perceived flystrike risk, attitudes towards phasing out mulesing and perceived 'barriers' to behavioural change.

Some key questions that the survey aimed to answer:

- How common the procedure of mulesing is in the sheepmeat industry?
- What is the general perception of the importance of mulesing in the sheepmeat industry?
- What are the main drivers for the continuation of mulesing?
- What are the main drivers for the cessation of mulesing?
- What are the perceived barriers of moving towards non-mulesed systems?

The survey was then piloted on a range of sheep produces to ensure questions were clear and sufficient to produce accurate results. The final version of the survey is presented in Appendix 10.5.

Participants and recruitment

Australian sheepmeat producers (over 18 years of age) that either own or manage a sheep flock were eligible to complete the survey. The survey was confidential and anonymous. Post-codes were collected for the property location, as the sole identifier within the survey, however, if producers were interested in receiving a summary of the main findings, they were able to enter their preferred contact details, however, this field was not mandatory. This study was approved by the Human Ethics Committee of The University of Melbourne, ethics review number 16264-3.

Recruitment commenced in November 2020 and finished in April 2021. Potential participants were first identified through the research team's networks. For example, producer networks from the Animal Welfare Science Centre, the Mackinnon Project and professional connections including sheep veterinarians across Australia. Sheep farmers were also recruited via established industry databases including through BestWool/BestLamb networks, National Farmers Federation (NFF), Victorian Farmers Federations, Local Land Services and Meat and Livestock Australia communication networks. Invitations were made either by email, telephone or by hard copies sent directly to potential participants. In addition, the company Chi-Squared, a market research service provider, was hired to contact potential participants by telephone and to distribute hardcopies to their online database. The survey was also advertised on newsletters, online websites and social media (twitter account @flystrikeprevention_survey). Where databases were used, no personal information about members was provided unless participants indicated in the survey that they want to receive a summary of the key findings.

Participants' task

Participants were asked to complete a once-off survey. The survey comprised 44 questions in total. All questions in the survey were optional, with producers given the option to leave any question blank if they were unsure or preferred not to complete the question. Overall, survey participants had three options for completing the survey:

- **Online delivery:** A secure email link to the survey was provided to potential participants to complete at a time of their convenience. Access to the researcher via phone or email was offered in the case of questions regarding the survey. The Plain Language Statement appear at the start of the survey, stating that the survey is both voluntary and confidential. Participants will agree by pressing an 'agree' button to commence the survey. The electronic version of the survey will be uploaded to the Qualtrics Survey Software.

- **Paper-based:** Participants also had the option of completing a paper-based survey. A hard copy of the survey, plain language statement and a reply-paid enveloped was sent to potential participants.

- **Computer Assisted Telephone Interviewing (CATI):** Participants had the option to complete the survey by telephone at a time convenient to them. A total of n=150 participants were surveyed by phone and this task was conducted by the company Chi-Squared.

Competition of the survey took between 30 to 40 min, depending on the level of details provided by the survey participants in the open-ended questions. Survey responses were either submitted electronically directly to the researcher (CM) or via AusPost to the lead investigator place of work.

Sample size

We aimed to reach about 20% of sheep producers in Australia, across multiple different production systems including Prime Lamb, 1st cross ewe (Merino-cross), 2nd cross ewe-based lamb and Merino enterprises across different flystrike risk areas including high-, low- and uniform-rainfall zones. We considered that there are 31,136 agricultural business in Australia with sheep and lamb production systems (ABS Agricultural Commodities 2015-16). From the 20% of producers that were targeted, we obtained 610 surveys and 546 were filled out to a level of completion where the results could be utilized in the project. The response rate was 7%, which is within a similar range as previous studies conducted by the Animal Welfare Science Centre on stockpeople and producer attitudes (Coleman et al., 1998, Rice et al., 2020, Hemsworth et al., 2021). A total of 546 completed surveys was therefore deemed sufficiently large to investigate general attitudes and beliefs in relation to phasing out mulesing in the sheepmeat industry.

Survey Analysis

The survey consisted of continuous data (e.g., sheep numbers, labour units, etc) and categorical, ordinal (attitude statements using a five-point Likert scale) and binomial data (management questions where farmers responded yes/no). Survey data were analysed using a combination of descriptive statistics, Chi Squared analyses, Principal Component Analyses (PCA), correlations, regressions and structural equation modelling analysis. The main analyses were conducted using the statistical software SPSS. In addition, qualitative data from the survey was analysed using the Nvivo software.

5.2 Key findings

The main findings of this component indicate that producer attitudes towards mulesing are important drivers in the decision to run mulesed or non-mulesed operations. These attitudes comprise behavioural beliefs (the perceived effectiveness of mulesing), normative beliefs (the perceived influence of other stakeholders), and control beliefs (the perceived difficulty of phasing out mulesing). Overall, producers were more likely to run mulesed enterprises if they held more positive views in relation to the effectiveness of mulesing (e.g. believe that mulesing is 'the key' to prevent flystrike), if they perceived a high incidence of breech flystrike, if they perceived a high risk of flystrike in their property, if they perceived that shearers and other farmers preferred mulesed sheep (e.g., mulesed sheep are easier to shear and crutch) and if they perceived that running non-mulesed enterprises is difficult (e.g. alternatives to mulesing are time consuming, expensive and affect profitability). In contrast, producers were more likely to run non-mulesed enterprises if they held more negative views about mulesing (e.g., do not see the need for mulesing and trust in the effectiveness of the alternatives to mulesing), perceived a low risk of flystrike in their property, low flystrike incidence, if they perceived that listening to consumers is important, and if they believed that the industry is at risk if mulesing is not phased out. In addition, other factors such as economic incentives and rainfall were also seen as factors influencing, to some degree, the decision to run mulesed or non-mulesed operations. However, their contribution to the decision was smaller than attitudinal factors as shown by the correlations, regressions, and structural equation modelling analyses. While all attitudinal factors are important predictors, their level of contribution to the decision to run mulesed or non-mulesed enterprises slightly varied according to type of enterprise. For example, for meat-focused producers, behavioural beliefs (the perceived effectiveness of mulesing) are important factors influencing the decision to run mulesed or non-mulesed operations. For meat-wool producers, control beliefs (the perceived difficulty of phasing out mulesing) and other external factors such as lack of economic incentives are main drivers. For mixed producers, control beliefs are key factors influencing the decision. For wool-focused producers, behavioural beliefs, control beliefs and external factors such as rainfall are important drivers for the continuation of mulesing.

The main findings of each section of this component, that is, focus group, phone interviews and attitudinal survey, are presented below. Further details of survey results are presented in appendix 10.6.

Focus group

Focus group results indicate that, while the participants do not like the mulesing procedure, mulesing was considered one of the most effective methods to prevent flystrike. Mulesed sheep are perceived as "low risk" of flystrike, with comments reflecting the ease of management, such as *"It's a lot easier to crutch them"* and *"there's always more dags on unmulesed sheep".* Several stakeholders seem to encourage the continuation of mulesing. For instance, some farmers are willing to pay more for mulesed sheep, breeders receive economic benefits and shearers prefer mulesed over unmulesed sheep. Some relevant quotes included: "*breeders were getting about ten-fifteen dollars extra", "shearers always complain"* and *"mulesing makes [shearing] a lot quicker*". Overall, participants believed that it would be difficult to cease mulesing in the short-term. Perceived barriers were related to management and labour costs, chemical use (leading to chemical resistance), insufficient monetary incentives for breeding unmulesed sheep, lack of cost-effective alternatives/strategies to control flystrike in the short-term and "tradition". The perceived importance/effectiveness of mulesing and the perceived costs associated with ceasing mulesing seem to be important barriers for behavioural change.

Phone interviews with producers

A total of twenty, phone interviews were conducted with Australian sheep farmers. The researchers were satisfied with the level of data saturation (repetition) obtained from the discussions as interviewees provided similar key themes. Overall, there was an even number of producers running mulesed and non-mulesed operations. A total of ten farmers (n= 50%) self-reported to have started phasing out mulesing or stopped mulesing completely and 50 % (n=10) were still using mulesing as the main prevention method for breech flystrike. The main themes discussed are presented in Table 23, and a summary is presented in Figure 2.

Table 23. Main themes discussed during the phone interviews:

Main themes	Secondary themes
Behavioural beliefs (Perceived effectiveness of mulesing)	Perceived flystrike risk
	Best flystrike prevention method(s)
	Main management practices used to prevent/control flystrike
	Mulesing and ease of shearing and crutching
Normative beliefs (The perceived influence of others in the decision to have mulesed operations)	Perception of what farmers, in general, are doing to prevent flystrike
	The influence of consumers and the industry
	The influence of other farmers and shearers
	The role of the industry
Control beliefs (The perceived ability to phase out mulesing)	Main barriers to stopping mulesing
	Likelihood of phasing out mulesing in the short or long-term

Interviewees running unmulesed enterprises

There was a large variation in this group as some producers were currently phasing out mulesing while others have ceased mulesing for over 10 years. There were also variations in the type and size of the enterprises and years of experience. From the 10 producers classified as non-mulesing/ceased mulesing, 40% (n=4) had wool-meat enterprises, 50% (n=5) wool-focused enterprises, and 10% (n=1) meat-focused enterprises. Flock sizes ranged from 1,500 to 8,000 breeding ewes, with up to 19,000 sheep on one farm. Producer experience with working with sheep ranged from 2.5 years to over 40 years of experience.

Behavioural beliefs – The perceived importance of mulesing

All interviewees from this group, perceived flystrike as an important problem but believed mulesing was not the best method to prevent it. They all expressed high levels of trust in the current alternative management strategies to mulesing, with some producers pointing out that '*I can't see why a lot more people don't stop mulesing; we have really good chemicals, really good science on genetics, we know what the risk factors are, and we have a lot less sheep in Australia that 10 years ago'.* The main strategies used by the interviewees to mitigate flystrike risks were usually a combination of short- and long-term prevention methods. The most common strategies mentioned were crutching, with some producers crutching two times per year, shearing 'at the right time', reliance on long-lasting chemicals, deworming, nutrition management and breeding sheep with fewer wrinkles. Although most of the interviewees relied on chemical use, some concerns were raised regarding chemical resistance, while breeding sheep with fewer wrinkles was often considered the best long-term prevention strategy.

There was a tendency for producers with fewer years in the sheep industry to hold stronger views in favour of ceasing mulesing. Some relevant comments from 'less experienced' producers included '*I reckon it's one of the cruellest things I've ever seen… mulesing and spaying heifers would be the two cruellest things I've ever seen', 'we are getting rid of mulesing for welfare reasons, just as simple as that… I have only been farming sheep for a few years, so I don't have the traditional mindset… I am ceasing purely because of welfare reasons'* and '*I can't see why some people are totally against moving away from mulesing. I think some farmers, particularly maybe the older generation are pretty staunch in their views'.*

Interviewees perceived producers are slowly adopting other flystrike preventive strategies, but believed mulesing is still a common practice in the sheep industry. According to the interviewees, mulesing is a practice that is very linked to tradition rather than an effective preventing method, with relevant quotes including, *'Mulesing is a traditional practice, you mules your Merinos. I know some people still mules their crossbreds but it's just not necessary'*, *'There are a lot of traditional sheep producers, but I think it's ridiculous that people are mulesing crossbred sheep, wethers or ewe-lambs, It's unnecessary'* and *'Mulesing is more common in the sheepmeat industry than I realised, someone around here had crossbred, which couldn't get more plain body if you tried, and he was mulesing!'.*

Normative beliefs – The perceived influence of others

Reasons given by the interviewees to cease having mulesed sheep in their farms were mainly ethical reasons, social pressures, and financial benefits. With producers indicating that '*People know that [mulesing] is a painful and pretty tough thing to do to a sheep*', '*I suppose from an ethical standpoint, we're totally against [mulesing]. We just don't see a need for it, because it's definitely possible to breed sheep that don't need it, in our opinion', 'well, I am getting premium, so we don't want everyone to stop mulesing because otherwise, I won't get my premium, having said that… If you don't see the social impact and the risk the industry is taking by not ceasing mulesing…. you got to be blind*' and *'I believe we need to move forward and look at what our consumers wants'.*

According to the interviewees, the decision to stop having mulesed sheep on their farms was not a decision directly influenced by others, but some interviewees mentioned that it is something that they discussed with their farm consultant and sometimes stock agents. *'I was thinking about [phasing out mulesing] for a long time, and I recently talked to my agent and my farm consultant… and my consultant is very pro non-mulesing, it is something that I have been thinking about since the industry said mulesing was going to be phased out'.*

The influence of shearers seems to have some effect on the decision to phase out mulesing. All interviewees acknowledged that shearers usually complain and prefer '*mulesed sheep with no tail*'. Thus, some farmers are willing to pay shearers a bit more to *'keep them happy',* while others believed that shearers should have vast experience with shearing non-mulesed sheep as they usually travel overseas. The influence of other farmers was also limited, with some relevant quotes including, *'I don't really talk to many people to ask them what they think' , 'everyone is doing their own thing, there is not much cooperation', 'I think everyone is fiercely independent and wishes to run their own show, we don't share notes in this area'* and *'Influencing other farmers doesn't happen unless the person has got it in his mind that he wants to stop mulesing'.* While the influence of other producers seems to be limited, some interviewees were very interested in helping out other producers with the transition, with one particular

producer commenting *'I have no problems if anyone asks me how to do it. I would sit down and take him through a program, I would design a program that will help to stop mulesing'.*

The role of the industry with phasing out mulesing was also discussed, with some contradicting point of views by the interviewees. Some interviewees believed that the industry, including AWI and other agricultural departments, provide *'really good information, fact sheets and extension materials'* to support farmers with the transition, while others think the industry needs to be more proactive, with relevant quotes including *'I don't think the industry here understands how big of an issue it is for customers and retailers, [the industry] has been disappointing – shown no leadership. Even locally, our brokers haven't either'* and *'I think they're sort of looking over the fence and just sort of watching'.*

Control beliefs – The perceived ability to do it

The majority of the interviewees identified themselves as living in a low fly risk area, which, they recognised, influenced their beliefs towards the importance of mulesing. Some relevant quotes from the interviews included *'In our environment, we don't have the same moisture that might lead to flies. In my mind, we don't need to be mulesing'*, '*I'm 100% for going against mulesing. I think it's unnecessary, but I can't speak for every environment though. I know different areas have different pressures and different rainfall'* and *'the general view in the district is that flystrike is quite important, for us the risk for flystrike is minimal, we don't have many issues with flystrike, perhaps because we manage in a way that we don't have issues'.*

When producers were asked about the main barriers to phasing out mulesing in Australia, the main comments were around the challenges with location differences, as some areas are more at risk than others, and producer's 'traditional thinking'. Some relevant quotes from the interviewees included *'getting rid of mulesing in some southern high rainfall summer environments and high rainfall environments is far more difficult', 'Most people are not in the position to stop mulesing. They would need to go through the process of breeding'* and *'The fact that farmers do mulesing for a reason is very powerful, there's too much tradition I suppose in the sheep industry in my view, especially with merinos'.* Another issue concerning barriers to phasing out mulesing was around enforcing the regulation, with some producers questioning '*how is anyone going to know if they've been mulesed or not?*'

Interviewees that are running mulesed enterprises

Most of the interviewees in this group were wool-meat producers. Flock sizes ranged from 470 to 8,000 breeding ewes, with up to 15,000 sheep on one farm. Producer experience with working with sheep ranged from 3 years to over 40 years of experience.

Behavioural beliefs – The perceived importance of mulesing

All interviewees in this group had strong positive views around the effectiveness of mulesing, with participants commenting that *'mulesing is the key' to mitigate flystrike, especially when used in 'combination [with], good management- health management, nutrition and genetic selection'*, *'...physical and chemical are the two best [methods to prevent flystrike] ...So there's mulesing, crutching, shearing and chemical applications'* and *'... the number one is mulesing and then time of crutching and shearing, for my management tools.*

All producers in this groups consider mulesing to be *'extremely important'* for the ease of shearing and crutching, with a majority agreeing that mulesing *'certainly makes it [crutching and shearing] easier'* and

'*faster*'. One producer estimated that crutching *'would probably be 20 percent slower... if they haven't been mulesed, … because they always have extra dag on them.'*

Comments were also made in relation to the health and welfare of sheep if mulesing is phased out, relevant quotes included '*we take the health of our sheep and all our animals so seriously';* '*I've got an obligation to make sure that my animals are happy and healthy for the duration of the time that they're with me*' and '*... the number one priority is the welfare of the sheep. So, what risk would we put large numbers of sheep if we phased out mulesing and people don't have management tools to look after them'*. Overall, mulesing was perceived as a short-term painful procedure that has long-term benefits for the sheep, with producers commenting that *'the increased incidence of flystrike… is much more detrimental to the welfare of the animal than mulesing'* and *'it's inhumane not to mules' as a one-off procedure is viewed as less harmful for the sheep as opposed to multiple crutching events throughout the year'.*

Normative beliefs – The perceived influence of others

Most participants agree that there is an influence of other farmers and shearers on their decision to continue mulesing, especially with the latter. *'Yeah*. *I definitely think it is going to affect me*'; '*It always does. Peer pressure always plays a part.'* and '*...I think shearers have definitely had an influence over the type of sheep we've got now.'* Furthermore, interviewees predominately acknowledged that shearers complain and '*get extremely frustrated [if mulesing were stopped]… and I don't blame them, trying to crutch and shear unmulesed sheep, it's particularly difficult*'. Other quotes supporting this include, '...*there has been definitely a level of influence by the shearing industry because shearers have gone to the guys with too much excess skin on their sheep and said, look, if you're going to produce them like that, we're not going to come back to shear them';* '*The only comment [from shearers] I get is "I'm glad you mules",'* and '*They prefer merinos that are mulesed*'.

In addition, according to most interviewees, monetary incentives seem to have some effect on their decision to continue mulesing. '... *the price we're getting for livestock is very good and it's covering costs',* and '*When you sell sheep, you get more for them when they're mulesed.*'

The role of the industry was also briefly discussed, with a large proportion of participants commenting on the importance of public education and how the industry fails to properly educate the public on the long-term welfare benefits of mulesing. *'I think it's important [on educating the general public] there has to be a very, very skilled marketing program.'* and *'...we haven't done, as an industry, a really good job of explaining how important mulesing is for the long-term health benefits of those sheep... like with the pain management tools we've got available now, I think the industry did quite a poor job early on in explaining.*' One interviewee highlighted the importance of pain relief and how the industry should be proactive on legislating mandatory pain relief. '...*and it needs to be done straightaway is to make pain relief mandatory. I mean, that first of all, sends a message, an important message that we're conscious of the welfare of animals*.'

Control beliefs – The perceived ability to do it

Most producers classed in this group indicated that they resided in a high fly risk area, where flystrike incidences are of 'high prevalence', which may influence their perception around the importance of mulesing. They all acknowledged, however, that the associated risks of flystrike can be 'reduced to zero' if their property is 'well managed' and other 'preventative measures' take place.

Producers that are currently mulesing find that the main barriers to stop mulesing pertain to difficulties

with management, costs with treatment, running *'less profitable sheep,*' and animal welfare concerns due to flystrike. Relevant quotes included '*I'm pretty time poor as it is, so to get sheep in to treat for flystrike, and only for flystrike will put more stress on [the] animal and on me. Lack of labour, the moral problem I've got about losing sheep to flystrike, that could have lived and could have not had a horrific death because we could have just mulesed,'; 'More hours spent physically monitoring the sheep,'* and '*Labour requirement would increase $2-4/sheep with contract crutching.*'

Another primary issue raised were concerns surrounding the '*greater use of chemicals.*' Some producers focused on how '*increased chemical use*' could pose a problem as they '*would be relying on more chemicals to treat flystrike or flystrike prevention. So, that would lead to chemical resistance in flies and... more chemicals involved... is also something that the consumer doesn't really want.*'

When interviewees were asked about the likelihood of phasing out mulesing, almost all agreed that it was possible in the long run, if there were viable alternatives. '*... not until there's an alternative like a roll-on caustic thing that tightens the skin up around there and stops wool growing in that area.*' and '*No, in the next 5 years no I don't. Not without some other sort of technique being developed like freezing the skin or an injection... or something you can paint on the area*.'

Producers running mulesed enterprises		Producers running non-mulesed enterprises
Perceived that mulesing is the most effective method to prevent flystrike	**Behavioural beliefs (The perceived importance of mulesing)**	Perceived that flystrike can be prevented effectively with management and breeding, no need for mulesing
Shearers preferred mulesed sheep Some farmers are willing to pay more for mulesed sheep	**Normative beliefs (The influence of others)**	Mulesing is a risk to the industry, It is important to listen to consumer
Perceived that alternative to mulesing are costly (more management less profitability), increased labour, and are time consuming	**Control beliefs (The perceived ability to phase out mulesing)**	It is not difficult to manage unmulesed sheep, perceived low risk and incidence of flystrike Perceived an economical benefit

Fig 2. Summary of key themes discussed in the phone interviews with producers.

Phone interviews with shearers

A total of eleven phone interviews were conducted with Australian shearers. Overall, most shearers interviewed believed mulesing is the most effective method in preventing flystrike and that banning mulesing in Australia would be detrimental to sheep welfare. A few, in contrast, believed that it is a socially unacceptable practice, and the ban is acceptable if there were effective alternative strategies available. Most participants perceived that mulesing is becoming less common in the sheepmeat industry and is mostly practiced in Merino sheep.

The main themes discussed with shearers are presented in Table 24.

Table 24. Main themes discussed during the phone interviews with shearers:

Main themes	Summary statements
Behavioural beliefs (Perceived effectiveness/importance of mulesing)	Most perceived that mulesing is the most human method to prevent flystrike
	Few perceived that mulesing is a socially unacceptable practice and are open to alternatives
	Six out of eleven shearers interviewed are against banning mulesing
Normative beliefs (Perceived influence of other stakeholders)	Few shearers commend New Zealand's mulesing ban and believe Australia should also implement a ban
	Most shearers interviewed believed that New Zealand has different environmental conditions and less wrinkled/less merinos, thus are able to gain productivity and profitability without mulesing
Control beliefs (Perceived ability/difficulty to phase out mulesing)	All shearers interviewed agree that mulesing makes shearing much easier (less dags, less wrinkle thus lowers risk of cutting, time-effective, etc.)

Behavioural beliefs – the perceived effectiveness of mulesing

Most shearer interviewed had strong positive perceptions around the effectiveness of mulesing, with participants aware that mulesing is a painful procedure but believed that it is a '*necessary evil,'* to prevent flystrike, and that it is a '*short term pain for [a] long term gain,*' thus contributes to sheep welfare in the long haul and that it would be inhumane to ban mulesing:

'*I've thought that in a lot of instances it's a part of animal welfare, best practice… Go through a bit of pain for a longer-term gain.*'

On the contrary, a couple of shearers believed that mulesing is a '*socially unacceptable*' practice and are aware of the effectiveness of other alternatives/strategies. One commented:

'*If the normal run-of-the-mill people saw it, what was being done [mulesing] then it would be banned. So, basically, I think it's not a practice that we're interested in pursuing.'*

When asked about their opinion on banning mulesing in Australia, only one shearer was for the ban:

'*That wouldn't worry me at all. Because basically, that clears the industry up. That takes away any negative… the socially unacceptable [part]… I wouldn't have a problem with it at all, I believe that's how it should be.*'

Four shearers were '*undecided;*' and perceived it was acceptable if there were effective alternatives/strategies present and/or believed it was acceptable as it only affects certain breeds of sheep [Merino] and not the whole sheepmeat industry:

'*A ban would be okay. If you get to a point where you bred [sheep] that don't have associated problems.'*

'*I can't see it being too much of a problem because they are that crossbred type… I don't think it will be quite as dramatic in the meat industry as it will be in the wool industry.'*

The remaining six shearers were strongly against banning mulesing, with most comments reiterating that it is '*inhumane*' to not mules sheep as mulesing promotes sheep welfare by effectively preventing flystrike:

'*You can't have a meat industry with sheep without having a wool industry as well. One comes with the other sort of thing. You have to take the wool off to send them to the abattoirs… so you have to shear them. So yeah, mulesing is a lot less stressful on the animal, it has a better, happier life, for those 30 seconds of displeasure when they're little… They're being eaten alive and that 90% of the time is because they haven't been mulesed… when you see them in distress like that, it's a horrible thing to see.'*

Normative beliefs – the influence of other stakeholders

Most participants agreed that mulesing is not a common practice in the sheepmeat industry or is becoming less common, and it is mostly practiced for Merino ewes and wethers, and first cross ewes:

'*Well, I reckon it's become less common… Even the ewes that produce the lambs can't be mulesed*' and '*Certainly not common in prime lamb industry, non-existent in the prime lamb industry.'*

Two other shearers were confident that mulesing is a common practice in the sheepmeat industry:

'*I would say yes, I've shorn in a lot of different states and just about everyone I've shorn they mules their sheep.'*

Control beliefs – the perceived difficulty of phasing out mulesing

All interviewees agreed that mulesing makes shearing much '*easier*' as there is '*less dag*' present, less wrinkles which prevents accidental cutting with the handpiece, and is generally more time and cost-effective:

'*It's just about the time management. The crossbreds, because they are tight skinned meat sheep, they don't need to be mulesed and they're less of a problem. But with the Merinos because of the wrinkle, you've got to fold the wrinkle and tighten the wrinkle to try shear and crutch it without taking chunks of skin out, which slows you right down. So, if you're doing Merinos all year and they were all unmulesed and they were quite wrinkly, fine wools, you'll be losing a lot of money over the whole year*.'

A few shearers even claimed to refuse shearing if a producer had unmulesed sheep:

'*I would refuse to crutch unmulesed Merinos. I still think it's cruel… people think it's cruel to mules them, but they're not the ones shearing them and crutching them twice a year, and the ones that have to get cleaned up…always get cut. I have refused to crutch at one property because they were unmulesed. But they were extremely bad so I just packed my stuff up and left.*'

A couple of shearers, in contrast, mentioned that other strategies such as crutched sheep pre-shearing, genetics and/or breeding may contribute more to the ease of shearing than mulesing:

'*Well, it doesn't impact it [shearing] at all if the sheep are crutched by the farmer or crutched by someone else pre-shearing. If sheep are crutched pre-shearing, there's no difference to shearing at all.'*

'*most shearers will say it's better to have mulesed sheep that non-mulesed sheep. But the industry's slowly moving towards bare breeching in breeding. So, there are sheep that are unmulesed that*

are quite shearable. An animal that's naturally bare breeched hasn't got too many wrinkles around the breech and therefore you don't have the problems that you have with breech wrinkle.'

Two participants further discussed that mulesing was dependent on the geographical area:

'*They [Bombala] used to be a non-mulesing area, because of their climate, they've got a cold climate so they've got less fly problems up there. But now, even in the last ten or fifteen years they're mulesing now too because the climate's changing, so it's getting warmer and there's more moisture for the flies. To a certain extent it is an area thing. If you live in a hot arid area… where the animals sweat… you've really got to do it [mulesing].'*

Attitudinal survey

A total of 56.2% of respondents reported to run mulesed operations and 43.8% reported to run non-mulesed operations. Most respondents that have mulesed operations reported using pain relief (89.3%), mainly Tri-solfen®. The majority of the respondents were from winter rainfall zones. The distribution of survey respondents is presented in Figure 3.

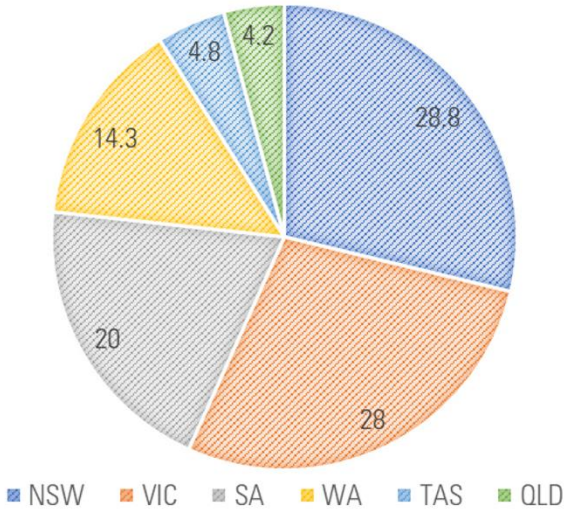


Fig 3. Distribution of respondents (n=546)

Similar to the phone interview results, there was an even spread between producers that have mulesed operations (56.2%) and non-mulesed operations (43.8%), results are presented in Table 25. Mulesing occurred across all type of enterprises, but it was significantly less common in meat-focused operations ($X^2_{(12, N = 542)} = 153$, p = .000, Table 26). Only 13.9% of meat-focused producers reported to have mulesed enterprises, while 67.6% of meat-wool producers, 63.9% of wool growers and 57.2% of mixedproducers self-reported to run mulesed operations. Most of these producers hired contractors to perform the procedure or mules themselves, and only a small percentage (0.7%) have mulesed enterprises solely because they had purchased mulesed sheep. It is worth considering that the survey targeted sheepmeat producers, and this may have led to the relatively low number of wool-focused

enterprises in the sample.

Table 25. Percentage (%) and frequency (in parentheses) of participants that either mules or ceased mulesing (n= 545).

Do you (or you contractor) currently mules your lambs?	Proportion of respondents (%)
Yes	52.8 (288)
Sometimes	2.7 (15)
Bought mulesed	0.7 (4)
No, but I have in the past	20.5 (111)
No, I have never mulesed my stock	23.3 (127)
Total respondents	**100** (545)

Total responses varied from 546 as some survey participants did not complete all questions in the survey.

Table 26. Percentage (%) and frequency (in parentheses) of participants that either mules or ceased mulesing according to type of enterprise.

Do you (or your contractor) currently mules lambs?	Type of enterprise			
	Meat-focused	Meat-wool	Wool-focused	Mixed production
Yes	8.9 (7)	65.1 (157)	61.3 (46)	52.4 (77)
Sometimes	2.5 (2)	2.5 (6)	1.3 (1)	4.1 (6)
I do not, but buy mulesed	2.5 (2)	0.0 (0)	1.3 (1)	0.7 (1)
No, but I have in the past	13.9 (11)	16.2 (39)	32.0 (24)	24.5 (36)
Never	72.2 (57)	16.2 (39)	4.0 (3)	18.4 (27)
Total respondents	**100** (79)	**100** (241)	**100** (75)	**100** (147)

Total responses varied from 546 as some survey participants did not complete all questions in the survey.

Location and perceived risk of flystrike are factors likely to influence the decision to have mulesed or non-mulesed operations. Results presented in Table 27 showed that there was a tendency for mulesed operations to be located in winter-predominant rainfall zones ($X^2_{(8, N=542)} = 15.3$, p=0.052). Analyses also disclosed a weak but significant negative relationship between perceived risk of flystrike and non-mulesed operations (Table 28), indicating that farmers that perceived a low risk offlystrike in their area/property are more likely to run non-mulesed enterprises (r= -0.126 p=0.005,and X^2= 21.7, p=0.04).

Table 27 Percentage (%) and frequency (in parentheses) of participants that either mules or ceased mulesing according to rainfall pattern (n= 542).

Do you (or your contractor) currently mules lambs?	What is your predominant rainfall period?		
	Winter rainfall	Uniform rainfall	Summer rainfall
Yes	54.2 (200)	55.0 (66)	37.7 (20)
Sometimes	3.3 (12)	2.5 (3)	0.0 (0)
Bought mulesed	0.3 (1)	1.7 (2)	1.9 (1)
No, but I have in the past	18.2 (67)	20.0 (24)	35.8 (19)
Never	24.1 (89)	20.8 (25)	24.5 (13)
Total respondents	**100** (369)	**100** (120)	**100** (53)

Total responses varied from 546 as some survey participants did not complete all questions in the survey.

Table 28. Percentage (%) and frequency (in parentheses) of participants that either mules or ceased mulesing according to perceived risk of flystrike (n= 495).

how would you rate the risk of flystrike in your area?	Do you (or your contractor) currently mules lambs?		Total
	Yes/Sometimes/buy mulesed	No, but I have in the past/Never	
1 (very low risk)	41.7 (15)	58.3 (21)	36
2	41.3 (31)	58.7 (44)	75
3 (moderate risk)	61.9 (78)	38.1 (48)	126
4	57.9 (81)	42.1 (59)	140
5 (very high risk)	60.2 (71)	39.8 (47)	118
Total respondents	**55.8** (276)	**44.2** (219)	**495**

Total responses varied from 546 as some survey participants did not complete all questions in the survey.

General views towards mulesing

Table 29 shows the levels of agreement or disagreement to key attitudinal statements included in the survey. Producers had to respond using a five-point Likert scale where a score of 1 indicated a strong disagreement and a score of 5 indicated a strong agreement (see example below).

	Strongly disagree	Disagree	Neither agree nor diagree	Agree	Strongly agree
The industry is at risk if mulesing is not phased out					
I think the industry should phase out mulesing					
A lot of farmers would stop farming sheep if mulesing is phased out in Australia					

When the whole set of survey respondents was examined (Table 29), it was found that a large proportion of survey respondents expressed positive views about the effectiveness of mulesing. Most survey respondents perceived that mulesed sheep are less at risk of flystrike (82.1%, agreed or strongly agreed), that mulesing has long-term benefits for the sheep (76.6%), and that mulesing is effective in reducing flystrike (69.9%). It is worth noting, however, that they were some differences between the groups (that is between respondents from meat-focused, meat-wool, wool-focused and mixed production enterprises). For example, meat producers agreed less to the statement *'there are currently no better alternatives to mulesing'* compared with other groups of respondents (p=0.044).

The influence of other stakeholders in the decision to have mulesed or non-mulesed operations was also expressed (Table 29). Shearers, other farmers, and consumers seem to play a role in the decision. On one side, a total of 80.9% of survey respondents agreed that shearers prefer mulesed sheep and 58.2% would pay more for mulesed sheep. On the other side, 57.1% think that the public does not support mulesing, 48.6% think that producers need to listen to consumers and 34.4% think that the

industry is at risk if mulesing is not phased out. There were no significant differences disclosed between the groups (meat-focused, meat-wool, wool-focused and mixed production enterprises).

The perceived difficulty in adopting alternatives to mulesing was also asked of the participants. Overall, 53.7% of the respondents considered that it was/would be difficult to phase out mulesing. However, meat producers significantly agreed less to this statement compared with the other group of respondents (p= <0.001). Overall, 47.3% perceived that, alternatives to mulesing are expensive, 36.6% agreed that there is not enough information about strategies to phase out mulesing and 28.8% do not know what the best approach is to phase out mulesing in their properties. Again, meat producers significantly agreed less with the statement '*I don't know what the best approach is to phase out mulesing on my property'* compared with the other groups (p=0.044). Overall, 57% of the respondents stated that they cannot currently see an economic benefit in ceasing mulesing, but 37.3% agreed/strongly agreed that they would phase out mulesing if there was a monetary incentive (no differences were disclosed between groups).

Data were also analysed according to whether farmers run mulesed or non-mulesed operations and clear differences were observed between these two groups of respondents (Table 30). Survey participants that run non-mulesed operations significantly disagreed with statements related to the effectiveness or importance of mulesing such as *'there are currently no better alternatives to mulesing, I would pay more for mulesed sheep, mulesing is needed if you farm sheep, I can't see the economic benefit in phasing out mulesing*' and *'it is difficult to get shearers if you have unmulesed sheep.'* This group of participants, however, significantly agreed with statement related to consumers' demands such as *'farmers need to listen to consumers'* and '*the public doesn't support mulesing*.' Survey participants that run mulesed operations, in contrast, significantly agreed to statements related to the efficacy of mulesing and the influence of shearers such as '*mulesing has long-term animal welfare benefits, 'mulesed sheep are less at risk of flystrike'* and *'shearers prefer mulesed sheep.'*

Key points

- Most survey respondents perceived (agreed or strongly agreed) that mulesed sheep are less at risk of flystrike (82.1%), that mulesing has long-term benefits for the sheep (76.6%), and that mulesing is effective in reducing flystrike (69.9%)
- A total of 80.9% of survey respondents agreed that shearers prefer mulesed sheep and 58.2% would pay more for mulesed sheep.
- 57.1% of respondents think that the public does not support mulesing, 48.6% think that producers need to listen to consumers and 34.4% think that the industry is at risk if mulesing continues.
- 47.3% of the respondents think that alternatives to mulesing are expensive, 36.6% agreed that there is not enough information about strategies to phase out mulesing.
- 37.3% of respondents stated that they would phase out mulesing if there was a monetary incentive.

Table 29. Percentage of participants' responses towards attitudinal statements.

Main Themes	Attitudinal statements in the survey	Strongly Disagree/disagree (%)	Neither agree nor disagree (%)	Agree/strongly agree (%)	Total (n)
Behavioural beliefs (The perceived importance of mulesing)	Mulesing is the most effective method to prevent flystrike	18.3	11.8	69.9	536
	There are currently no better alternatives to mulesing	24.8	12.1	63.1	528
	I would pay more for mulesed sheep	21.5	20.3	58.2	522
	Mulesing has long-term animal welfare benefits	12.9	10.5	76.6	533
	Mulesed sheep are less at risk of flystrike	11.5	6.3	82.1	537
	Mulesing is needed if you farm sheep	31.4	23.9	44.6	527
	Mulesing is painful for sheep	16.1	16.9	67.1	528
	Unmulesed sheep need more chemicals to prevent breech flystrike	16.1	12.3	71.6	529
Normative beliefs (The perceived influence of others in the decision to mules)	Shearers prefer mulesed sheep	10.3	8.8	80.9	533
	A lot of farmers would stop farming sheep if mulesing were phased out in Australia	22.2	25.6	52.3	532
	Most Australian farmers have mulesed sheep	12.7	32.2	55.1	528
	Shearers charge more for unmulesed sheep	51.7	30.8	31.3	530
	Farmers need to listen to consumers	20.7	30.8	48.6	533
	The industry is at risk if mulesing is not phased out	41.1	24.4	34.4	532
	I think the industry should phase out mulesing	50.8	22.0	27.2	532
	The public doesn't support mulesing	12.2	30.7	57.1	531
	I think that most farmers are not prepared to phase out mulesing	13.7	26.6	59.6	533
	I think the industry needs to educate the public about mulesing	16.7	10.2	73.2	532
Control beliefs (The perceived ability to phase out mulesing)	It is difficult to crutch unmulesed sheep	22.9	14.4	62.7	521
	It is difficult to shear unmulesed sheep	24.9	19.7	55.4	517
	It was/would be difficult for me to phase out mulesing	30.3	16.1	53.7	522
	I don't feel prepared to phased out mulesing	45.3	20.8	33.8	520
	Alternatives to mulesing are expensive	19.3	33.5	47.3	529
	If mulesing is phased out, I will not farm sheep	49.7	21.6	28.7	523
	I can't see the economic benefit in phasing out mulesing	26.2	16.7	57.1	522
	It is difficult to get shearers if you have unmulesed sheep	31.1	25.3	43.6	521
	I would phase out mulesing if there is an economic benefit	24.6	38.1	37.3	509
	I don't know what the best approach is to phase out mulesing on my property	36.4	34.7	28.8	507
	I don't know what the best approach is to prevent flystrike on my property	70.2	16.3	13.5	520
	There is not enough information about strategies to phase out mulesing	28.9	34.5	36.6	530

Main Themes	Attitudinal statements in the survey	Mean score Mulesed	Mean score Non-Mulesed	F	p-value
Behavioural beliefs (The perceived importance of mulesing)	Mulesing is the most effective method to prevent flystrike	4.4	3.2	145.9	<0.001
	There are currently no better alternatives to mulesing	4.3	2.8	201.3	<0.001
	I would pay more for mulesed sheep	4.1	2.9	146.1	<0.001
	Mulesing has long-term animal welfare benefits	4.5	3.5	91.0	<0.001
	Mulesed sheep are less at risk of flystrike	4.5	3.8	50.7	<0.001
	Mulesing is needed if you farm sheep	3.8	2.4	168.5	<0.001
	Mulesing is painful for sheep	3.6	3.9	14.5	<0.001
	Unmulesed sheep need more chemicals to prevent breech flystrike	4.3	3.3	98.3	<0.001
Normative beliefs (The perceived influence of others in the decision to mules)	Shearers prefer mulesed sheep	4.5	3.9	38.7	<0.001
	A lot of farmers would stop farming sheep if mulesing were phased out in Australia	3.7	3.1	47.9	<0.001
	Most Australian farmers have mulesed sheep	3.8	3.3	28.6	<0.001
	Shearers charge more for unmulesed sheep	3.2	2.6	39.8	<0.001
	Farmers need to listen to consumers	3.1	3.7	32.3	<0.001
	The industry is at risk if mulesing is not phased out	2.0	3.3	41.9	<0.001
	I think the industry should phase out mulesing	2.0	3.3	133.6	<0.001
	The public doesn't support mulesing	3.5	3.9	19.2	<0.001
	I think that most farmers are not prepared to phase out mulesing	3.4	3.6	15.0	<0.001
	I think the industry needs to educate the public about mulesing	4.2	3.5	36.7	<0.001
Control beliefs (The perceived ability to phase out mulesing)	It is difficult to crutch unmulesed sheep	4.2	2.9	158.4	<0.001
	It is difficult to shear unmulesed sheep	4.0	2.8	130.3	<0.001
	It was/would be difficult for me to phase out mulesing	4.0	2.5	209.7	<0.001
	I feel prepared to phase out mulesing	2.2	3.6	159.2	<0.001
	Alternatives to mulesing are expensive	3.7	3.0	56.4	<0.001
	If mulesing is phased out, I will not farm sheep	3.1	2.0	104.7	<0.001
	I can't see the economic benefit in phasing out mulesing	3.9	2.9	83.5	<0.001
	It is difficult to get shearers if you have unmulesed sheep	3.7	2.5	131.5	<0.001
	I would phase out mulesing if there is an economic benefit	3.0	3.3	8.6	.004
	I don't know what the best approach is to phase out mulesing on my property	3.2	2.3	87.4	<0.001
	I don't know what the best approach is to prevent flystrike on my property	2.2	2.0	2.4	.125
	There is not enough information about strategies to phase out mulesing	3.2	3.0	4.5	.035

A mean score closer to 1 indicates a strong disagreement and a mean score closer of 5 indicates a strong agreement to the statements. Survey respondents were classed as 'mulesed operation' if they responded yes or sometimes to the question 'do you (or your contractor) mules lambs on your property? Or if they buy mulesed sheep.' If they responded no, but I have in the past or responded never, then they were classed as 'non-mulesed operation'.

Main reasons against having a mulesed operation

The main reasons for having non-mulesed operations were examined according to type of enterprise(Table 31). For meat-focused producers, the three main reasons were 1) not seeing the need due to the type of sheep they manage, 2) perceived a low risk of flystrike and 3) animal welfare concerns due to the pain involved. For meat-wool producers, the main reasons were 1) animal welfare concerns, 2) price premium on non-mulesed fleece wool followed by 3) not seeing the need to have mulesed sheep. For mixed producers, the main three reasons were 1) not seeing the need to have mulesed sheep, 2) animal welfare concerns and 3) perceived low risk of flystrike. For wool producers, there were two main reasons 1) animal welfare concerns and 2) premium on non-mulesed fleece wool.

Table 31. Percentages (%) and frequency (in parentheses) of participants' main reasons for notmulesing according to type of enterprise (n= 228).

If you are currently not mulesing, what is the main reason for not mulesing?	Type of enterprise			
	Meat-focused enterprise	Meat-wool enterprise	Wool-focused enterprise	Mixed production
Price premium on lamb	8.3 (5)	1.3 (1)	3.8 (1)	6.1 (4)
Price premium on non-mulesed wool	3.3 (2)	17.1 (13)	30.8 (8)	9.1 (6)
Low flystrike risk	23.3 (14)	10.5 (8)	0.0 (0)	13.6 (9)
Cost of mulesing	0.0 (0)	1.3 (1)	0.0 (0)	0.0 (0)
Animal welfare	21.7 (13)	46.1 (35)	46.2 (12)	25.8 (17)
I don't see the need	38.3 (23)	11.8 (9)	3.8 (1)	27.3 (18)
Consumer demands	0.0 (0)	5.3 (4)	3.8 (1)	9.1 (6)
Other	5.0 (3)	6.6 (5)	11.5 (3)	9.1 (6)
Total respondents	**100** (60)	**100** (76)	**100** (26)	**100** (66)

Main reasons in favour of having a mulesed operation

The main reasons for having mulesed operations were also examined according to type of enterprise (Table 32). For meat-focused producers, the main reasons for mulesing were in relation to high incidence of flystrike, a perception of high flystrike risk, the costs associated with extra management and the perception that there are no better strategies to control flystrike than mulesing. Tradition was also mentioned as a reason, with one producer commenting that 'it is a culturally acceptable practice.' Main reasons for having mulesed operations for meat-wool, wool and mixed producers were somewhat similar. The two most common reasons were 1) the perception that there are no better strategies to control flystrike than mulesing and 2) a perception of high risk of flystrike. The majority of the respondents that have mulesed operations reported using pain relief (89.3%), and the most common product used was the topical local anaesthetic, Tri-Solfen.

Table 32. Percentage (%) and frequency (in parentheses) of participants' main reasons for mulesing according to type of enterprise (n= 304).

If you are currently mulesing, what is the main reason for mulesing?	Type of enterprise			
	Meat-focused enterprise	Meat-wool enterprise	Wool-focused enterprise	Mixed production
High incidence of breech strike	27.3 (3)	19.5 (32)	6.5 (3)	10.8 (9)
High flystrike area	18.2 (2)	25.6 (42)	30.4 (14)	20.5 (17)
Cost of extra crutching	18.2 (2)	1.8 (3)	2.2 (1)	3.6 (3)
There is no good alternative to mulesing	18.2 (2)	37.2 (61)	37 (17)	42.2 (35)
Tried ceasing mulesing but unsuccessful	0.0 (0)	4.3 (7)	4.3 (2)	9.6 (8)
Ease of management	0.0 (0)	3.7 (6)	8.7 (4)	8.4 (7)
Shearers and other stakeholders' pressure	0.0 (0)	1.8 (3)	2.2 (1)	2.4 (2)
Cultural/tradition	9.1 (1)	0.6 (1)	0.0 (0)	0.0 (0)
All options	0.0 (0)	2.4 (4)	6.5 (3)	0.0 (0)
Other	9.1 (1)	3.0 (5)	2.2 (1)	2.4 (2)
Total respondents	**100** (11)	**100** (164)	**100** (46)	**100** (83)

While the mulesing operation was more prevalent in Merino-based enterprises, the survey results revealed that mulesing also occurred in Merino 1st cross and 2nd cross-based operations. Therefore, we examined the main reasons for mulesing according to sheep type. Main reasons for mulesing or having mulesed operations followed the same trend across the different types of sheep examined. The most common reasons were the perception that there better strategy to control flystrike than mulesing, the perception of high incidence of breech strike and the perception of high risk of flystrike (Figures 4, 5 and 6).

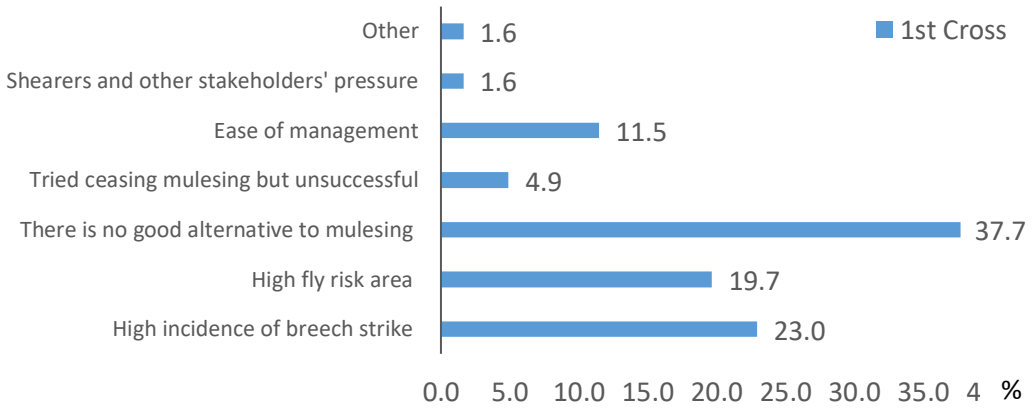


Fig 4. Main reasons for mulesing 1st cross Merino sheep (based on 60 survey respondents)

Fig 5. Main reasons for mulesing 2nd cross Merino sheep (based on 12 survey respondents).

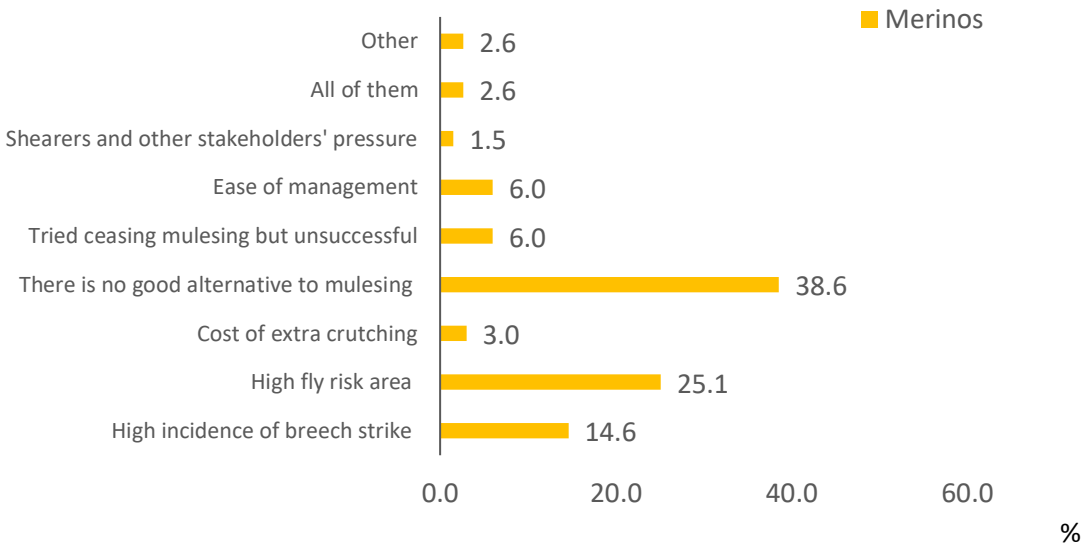


Fig 6. Main reasons for mulesing Merinos (based on 275 survey respondents).

Based on the correlation and regression results, a structural model was conducted (Figure 7) illustrating the relevant factors that influence producers' decisions to run mulesed operations. The model is based on the combined data for all enterprises. Overall, attitudes are important drivers for the continuation of mulesing, with control beliefs (the perceived difficulty of phasing out mulesing) being the most influential factor. Economic incentives and rainfall also influenced the outcome (the decision to run mulesed or non-mulesed operations), but their contribution is smaller than attitudinal factors. Number and font size indicate the level of contribution (e.g., 1. Perceived ease or difficulty to phase out mulesing was the biggest contributor followed by 2. Perceived need for mulesing).

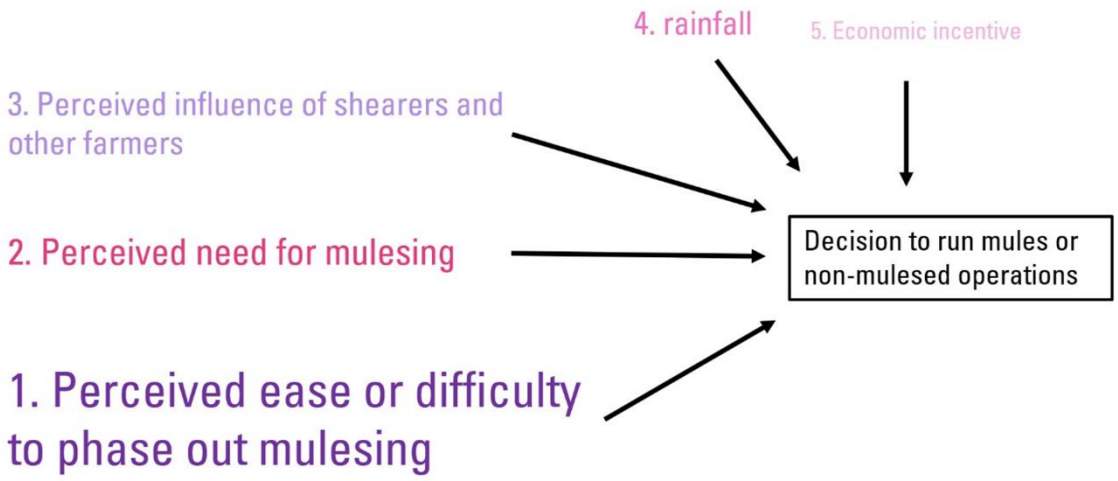


Fig 7. Important key factors that influence the decision to run mulesed or non-mulesed operations. Number and font size indicate the level of contribution (e.g., 1. Perceived ease or difficulty to phase out mulesing was the biggest contributor followed by 2. Perceived need for mulesing).

5.3 Take home message

Producer attitudes towards mulesing are important drivers in the decision to run mulesed operations or not. These attitudes comprise behavioural beliefs (the perceived effectiveness/need for mulesing), normative beliefs (the perceived influence of other stakeholders, e.g., shearers prefer mulesed sheep and other farmers are willing to pay more for mulesed sheep), and control beliefs (the perceived difficulty of phasing out mulesing e.g., costly and time consuming).

Understanding that producer attitudes are main drivers for the decision to run mulesed or non-mulesed operations is important because attitudes are learned predispositions and can be changed. This indicates an opportunity to develop a targeted program (addressing key drivers and barriers to the adoption of non-mulesed operations) to support farmers in the decision to transition to non-mulesed enterprises.

The following section addresses the development of an intervention strategy to support farmers transition to non-mulesed operations. This section was informed by results from components 1, 2 and 3 and it was progressed in close liaison with the producer advisory group for this project.

6. Intervention/extension strategy

6.1 Framework

For an extension strategy/program to be effective, it needs to be conducted along with a broader industry approach (Figure 8). The sheep industry (wool and meat industries) should take a leadership role with a collaborative approach, leading and supporting the transition by:

1) Working together with key industry stakeholders such as producers, stud breeders, shearers, stock agents, wool brokers, and meat processors.

2) Identifying market benefits and risks (e.g., potential market access or penalties) and communicating these to relevant stakeholders

3) Supporting the transition to non-mulesed enterprises through extension programs

4) Supporting and funding research focused on developing and refining short-term and long-term strategies to manage flystrike

5) Elaboration of an industry certification and/or labelling scheme

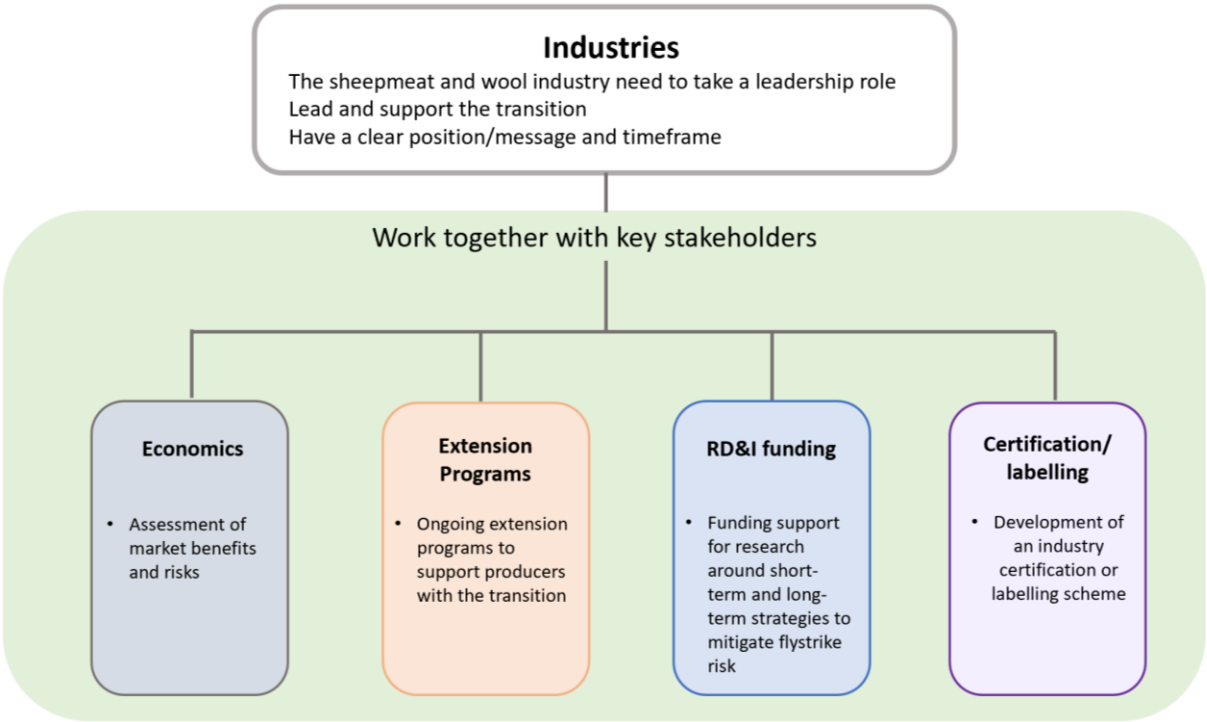


Fig 8. Extension strategies/programs should be integrated with a broader industry approach

Timeframe

This broader industry approach should be accompanied by a clear timeframe developed following a consultation process. Working with key stakeholders, understanding their opinions and concerns regarding phasing out mulesing, in a manner indicative of cooperation, can be an effective strategy. Setting a realistic timeframe for the transition is a key part of the process. It is important to set realistic short-term and long-term targets that can be embraced by key industry stakeholders. For this to happen, they need to be integrated in the conversation, thus, a consultation process with producers, shearers, processors, veterinarians and legislators should be considered. One short-term target that could be discussed, for example, could be national mandatory pain relief if the mulesing procedure is conducted.

Relevant to this project, in the next section we present in more detail the development of an extension/intervention strategy aiming to support farmers to transition to non-mulesed operations.

6.2 Extension strategy – Development process

1. **Identification of the target audience**: Sheepmeat producers that run mulesed operations
2. **What behaviour we want to address?** Mulesing in sheepmeat operations. We want to facilitate a transition to non-mulesed operations by increasing knowledge of and trust in short- and long-term strategies to control flystrike, by discussing the cost and benefits associated to phase out mulesing by trialling its on-farm practicality, and by raising awareness of the risks to social license.

To develop a targeted extension/intervention strategy, it is important to first understand what the key factors are, that influence producers' decision to run mulesed operations. The results of our survey indicated that attitudes are important drivers for the continuation of mulesing, with control beliefs (the perceived difficulty of phasing out mulesing) being the most influential factor, followed by behavioural beliefs, that is, the belief that mulesing is the most effective method to control flystrike. These are the key factors that will be targeted in the extension strategy; however, the influence of external factors should also be considered. This is why a broader industry approach is important: because behaviours do not occur in isolation, they are part of a system. For example, shearers were identified in this project as important stakeholders, as shearing/crutching unmulesed Merino or Merino crossbred sheep is perceived as costly and time consuming. Perhaps the industry needs to support shearers with specific extension programs and/or funding/subsidy to minimise the possible extra charge to producers for the extra time it might take to shear/crutch unmulesed sheep. Figure 9 illustrates the main factors identified in this project.

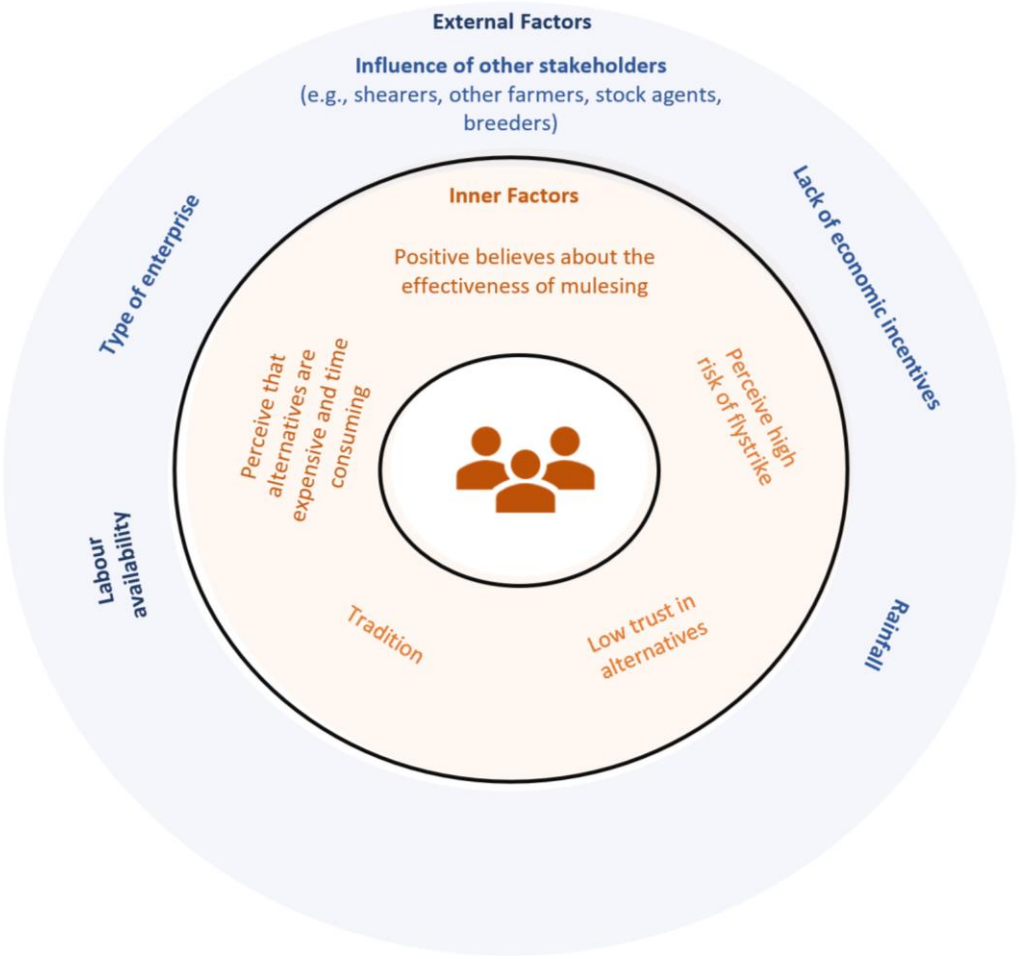


Fig 9. Main factors that influence producers' decision to run mulesed operations, as identified in this project.

In summary, results from the component 'Pathways and barriers to adoption' indicated that producers were more likely to run mulesed enterprises if they:

- Hold positive views about the effectiveness of mulesing
- Had low trust in alternatives to mulesing
- Perceive shearers prefer mulesed sheep
- Perceive high incidence of breech flystrike
- Perceive high risk of flystrike
- Perceive that other strategies to control flystrike are costly and time consuming

Producers were more likely to run non-mulesed enterprises if they:

- Work with shearers that are willing to work with unmulesed sheep
- Perceive that listening to consumers is important
- Believe that the industry is at risk if mulesing is not phased out
- Had trust in alternatives to mulesing
- Perceive less risk and low incidence of flystrike
- Perceive economic benefits by adopting alternative strategies to control flystrike

Identification of behavioural change technique: Based on the key findings from components 1, 2 and 3 the extension strategy proposed was designed using a cognitive-behavioural intervention approach.

6.3 Structure

The extension/intervention strategy can be delivered as an industry course that producers can sign up for a period of at least 24 – 36 months. The proposed extension strategy consists of four main components 1) Improving knowledge of and trust in short- and long-term strategies to control flystrike, 2) Provision of tools for decision making, 3) Tailored on-farm trials to encourage the use of short- and long-term strategies to control flystrike and 4) Increasing communication with consumers (Figure 10). The program should run in small groups of 8-10 producers from similar rainfall zones,

and this group should remain together for the duration of the program to facilitate peer learning. The intervention should be coordinated by a series of facilitators. In addition, each group of producers needs to have one or two producers perceived as 'influencers'; that is, local producers (same rainfall zones) that successfully phased out mulesing and that are willing to share their learning experience with others in the area.

Components 1, 2 and 3 should be delivered on-farm, and farm visits should rotate between participants' farms. Throughout the duration of the program, participants should have easy and clear communication pathways with the group facilitator, allowing continuous support and easy access to information. Details of what should be involved in each component is presented below.

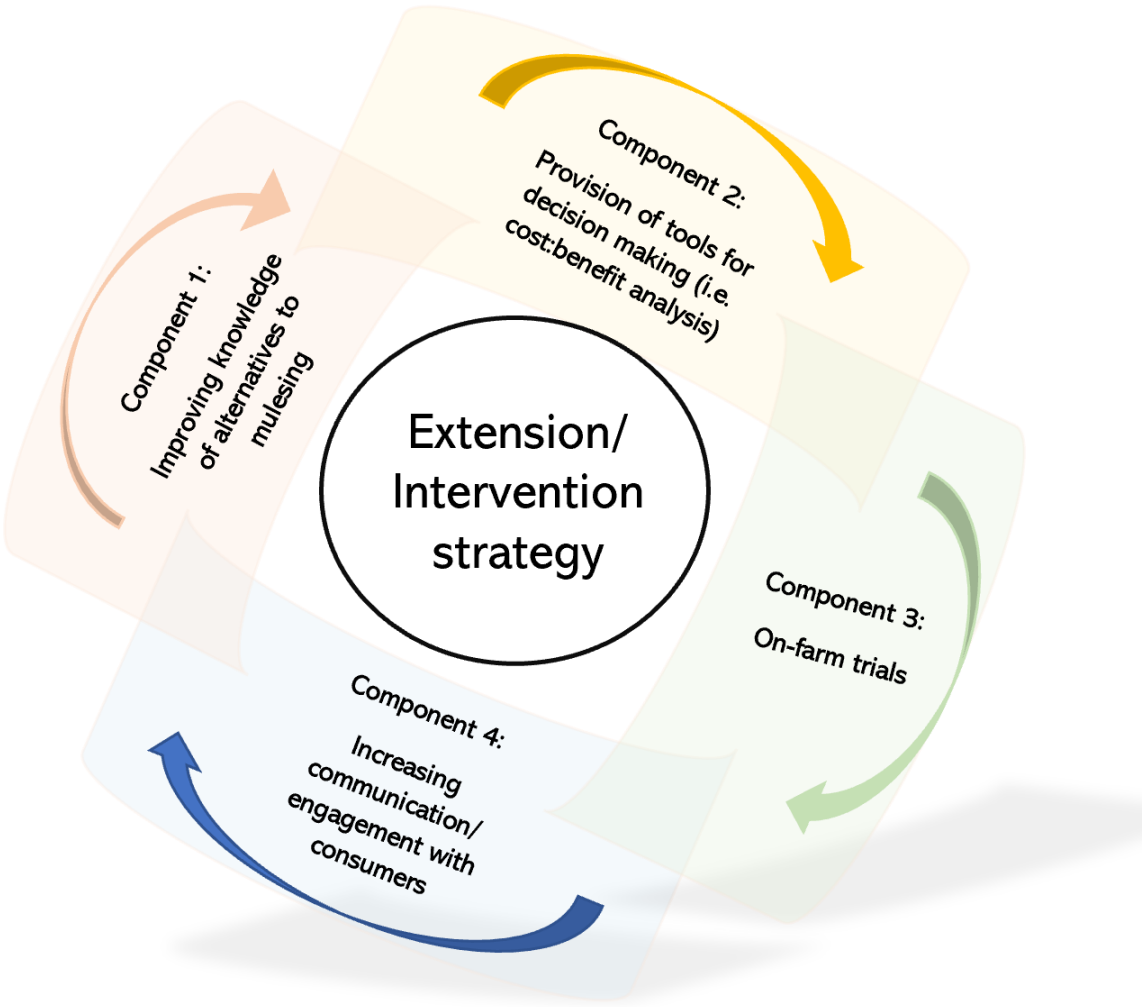


Fig 10. Main components of the extension/intervention strategy

Component 1: Improving knowledge of short- and long-term strategies to control flystrike and better access to information

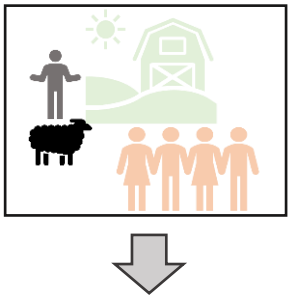
Rationale for including this component: Most of the survey respondents perceived that mulesing is the most effective method to prevent flystrike (69.9%) and that there are currently no better alternatives to mulesing (63.1%). A total of 36.6% of survey respondents agreed that there is not enough information about strategies to phase out mulesing.

Method of delivery:

The aim of this component is to expose farmers to science-based strategies for the control of flystrike as well as giving producers the opportunity to share and discuss their ideas, concerns, and experiences. This should be done mainly as an on-farm activity, but also be supported by computer-based activities. The first farm visit should be conducted on the 'influencer' producer's farm. This can also be used as a demonstration site during the program. During the first visit, the 'influencer' producer should talk about his/her experience with the transition to a non-mulesed flock, his/her motivation to transition, the challenges, and the benefits. There should be at least three on-farm visits during the year, that are organised specifically to provide information about strategies for the control of flystrike. These visits should be timed specifically to coincide with important times from a flystrike/risk reduction point of view. For these activities, guest speakers (e.g., other farmers, scientist, industry representatives, veterinarians) can be invited to present a topic each time. These subsequent visits can be arranged at different participants' farms. Following the farm visits, participants should be given access to a range of online materials such as fact sheets and interactive short videos with the key information that was discussed on the day, trying to address one topic at a time after each visit to not overload the participants with information. Participants should be able to access the online materials in their own time, and they should be able to access most of these materials on their smartphone as well. This online individual activity should be combined later with a Q&A group activity that could be delivered in person or online, depending on availability. This is to facilitate a group discussion and exchange of ideas and point of views about the learning content. One- or two-weeks post each of these activities, the facilitator should assess participants' knowledge by a short survey/questionnaire. This will allow tracking participants changes in knowledge in the short-term and can guide further discussions and clarifications of misconceptions.

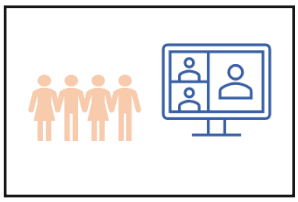
Structure: This component should be an ongoing activity throughout the extension strategy (at least 3 times a year) allowing producers continuous access to updated information and ongoing opportunities to share opinions with other producers involved in the program.

Step 1: Group activity. On-farm visits exposing farmers to science-based strategies for the control of flystrike

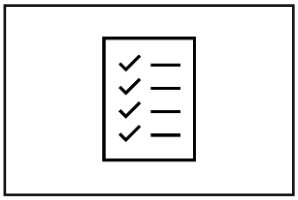


Step 2: Individual activity. One or two days later, participants should have access to online materials such as fact sheets, interactive short videos and producers' testimonials (relevant to what was mainly discussed during the farm visit).

Step 3: Group activity. One week later, a Q&A session with the group to facilitate discussion and exchange of ideas about the learning content.



Step 4: Individual activity. One- or two- weeks later, a short survey/questionnaire to assess change in knowledge.



Some key content/topics to address in this component:

Addressing behavioural beliefs (the perceived importance/effectiveness of mulesing)

The main objective of this component is to provide easy access to key information about the short-term and long-term strategies to control flystrike, addressing advantages and considerations. Particularly, addressing concerns about:

- Chemical use and chemical resistance on-farm
- Concerns that breeding for plainer bodied sheep can negatively impact fleece weight, wool quality, and the profitability of the enterprise.

Addressing control beliefs (The perceived ability to phase out mulesing)

- The content should also address the concerns that strategies to control flystrike (such as a second crutching, increased monitoring, chemical use, and genetics) are time consuming, expensive and affect profitability. The benefits, costs and considerations (pros and cons) around these strategies should be discussed. This could be addressed in short videos presenting producers' testimonials. This topic should also be reinforced in other components of this strategy (such as component 2 and 3). On-farm studies assessing current flystrike prevalence of unmulesed versus mulesed sheep could also be used to inform this content.
- The belief that non-mulesed enterprises cannot be implemented successfully in high rainfall zones. This can be addressed through face-to -face testimonials, fact sheets with case studies and short videos of producers' testimonials. Again, this topic should also be discussed/reinforced in component 3.

Addressing normative beliefs (The perceived influence of others)

- The belief that shearers (and other stakeholders such as other producers) prefer mulesed sheep as non-mulesed sheep affect ease of shearing. This can be addressed by including short interactive videos/interviews with shearers that are currently working with non-mulesed Merino or Merino crossbred-based enterprises. This is a very important point, and as mentioned before, it should be combined with an industry effort to support and work with shearers.

It is important to consider that a lot of this formation is already available to producers (some examples include the AWI program *It is fly time!*, the Flyboss website (that includes case studies, testimonials and the flystrike risk simulator), and various Victorian Farmers Federations livestock factsheets). So, with this component, we are not proposing necessarily to develop all these materials from scratch. Rather, the aim of this component is to facilitate the access to the information, tailored the information that is delivered to produces, according to their own concerns and needs and to provide continuous support and opportunities to share and discuss producers' ideas, concerns, questions and misconceptions about flystrike prevention, monitoring, and treatment.

Component 2: Provision of tools for decision making

Rationale for including this component: The costs associated with short- and long -term strategies to control flystrike in non-mulesed sheep, and the perceived high risk of flystrike in these flocks, were identified as main concerns for producers currently running mulesed enterprises. A total of 47% of survey respondents stated that alternative strategies to prevent flystrike are expensive, while 37.3% of the respondents stated that they would phase out mulesing if they could see an economic benefit. Continuous and easy access to information about the different strategies to control flystrike need to be combined with tools for decision making such as the cost:benefit analysis tool developed in this project. This will allow producers to identify their own costs associated with the decision to phase out mulesing. Existing tools such as the Flystrike Risk Simulator can also be included in the program.

Method of delivery

This component of the intervention strategy can be facilitated by a one-day workshop. During the day, the facilitator or an expert specifically engaged for this activity, should explain the assumptions used to develop the cost:benefit analysis and how to use this tool. Participants should be given examples using different case studies/scenarios and they should be encouraged to fill in the cost:benefit analysis spreadsheet using their own farm data, comparing what it might look like to run non-mulesed sheep on their property, with or without extra chemical application/crutching/monitoring, etc (Figure 11). After that, a one-on-one consultation session with the expert and the facilitator needs to be arranged with each participant to go through the results of the cost:benefit analysis and clarify questions. During the one-day workshop, other decision-making tools that are already available, such as the Flystrike Risk Simulator should also be discussed.

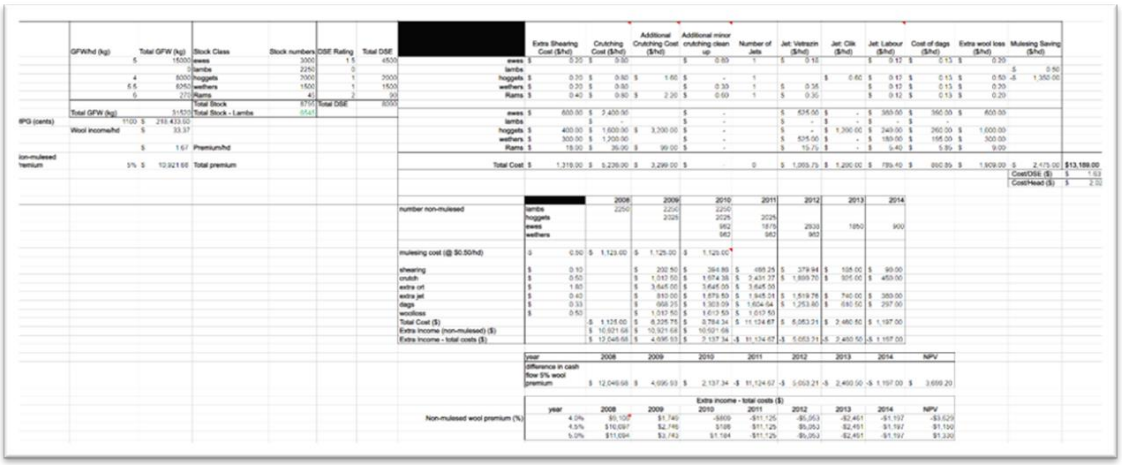
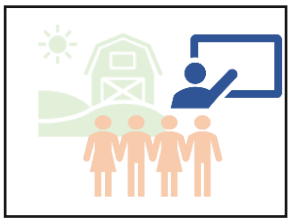


Fig 11. Example of the cost: benefit analysis spreadsheet

Structure:

Step 1: Group activity. One-day workshop session with other producers involved in the program.



Step 2: Individual activity. One-two weeks later, face-to-face, or online personalised consultation to discuss the cost: benefit analysis results.

Component 3: Tailored on-farm trials

Rationale for including this component: It should be noted that 80% of the survey respondents acknowledged that they did not receive guidance during the transition to non-mulesed operations, and 6% of the respondents running mulesed enterprises stated that they tried ceasing mulesing but were unsuccessful. Also, only 36.4% of survey participants stated that they know what the best approach is to phase out mulesing in their properties. Thus, continuous and easy access to information plus decision-making tools should be combined with hands-on experience and continuous on-farm support.

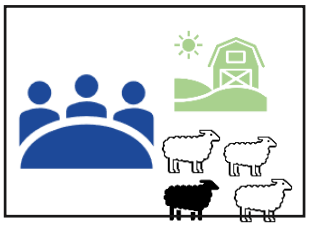
Method of delivery

Participants should be encouraged to trial a small mob of non-mulesed ewe lambs on their property and assess the outcomes and challenges of this exercise. Farm-specific management strategies should be discussed and tailored by the group facilitator, a consultant specifically engaged for this activity, and the producer. Farmers need to be provided with constant support by the facilitator and the consultant (this could be done through face-to-face, online or phone consultations throughout the program). Participants should also assess and compare flystrike prevalence of their unmulesed and mulesed sheep. Field days where participants visit each other's properties at least twice throughout the duration of the course should be coordinated by the facilitator so participants can discuss their strategies and exchange their experiences. Producers who are the 'influencers' should

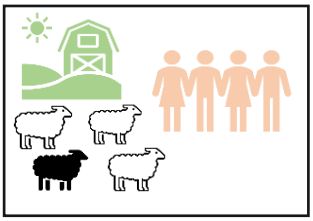
also be part of these activities and visit different properties and provide advice. Since the 'influencers' would have to commit a lot of their time to participate, some compensation for their time should be considered. Paper-based fact sheets and online materials with key information that has been discussed on the day about short- and long-term strategies to control flystrike and case studies/testimonials also need to be distributed among the participants during these field days to reinforce knowledge.

Structure:

Step 1: Individual activity. Set up an on-farm trial. On-farm visit by the facilitator and a consultant to tailored farm-specific management strategies to control flystrike in a non-mulesed mob



Step 2: Group activity. Two-three months later, field days with the producer group



Component 4: Increasing communication/engagement with consumers

Rationale for including this component: Results from the component 'Pathways and barriers to adoption' showed that producers were more likely to run non-mulesed enterprises if they perceived that listening to consumers was important, if they perceived that the public does not support mulesing, and if they believed that the industry's social license is at risk if mulesing is not phased out.

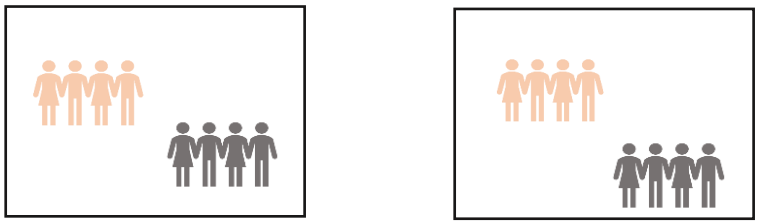
Method of delivery

The producer group should be invited to engage with the community at least once a year during the duration of the program. Face-to-face meetings should be organised and facilitated to promote exchange of knowledge, concerns, and expectations between the public and producers. Face-to-face meetings should run for about 90 min. These activities can be run as focus groups, which means that the group should be facilitated by an experienced focus-group coordinator and a semi-structed

agenda should be used to guide the conversation. During these meetings, producers could explain the mulesing procedure to the public and the short- and long-term alternatives to control flystrike and their motivations to participate in the program. This can be supported by short videos and testimonials prepared specifically for these activities. The Animal Welfare Science Centre has developed similar activities in previous studies and this material can be used as the groundwork to structure the content of these activities. Producers can share their own experience with the program and address consumers' questions and listen to consumers' concerns and expectations about animal health and welfare in the sheep industry. The number of participants should be kept small to encourage even participation of all the attendees. Perhaps, two sessions (each comprising n=5 producers and n=5 members of the public) should be run simultaneously on the day. These activities can be organised in meeting rooms in local venues near producers' locations. Increasing communication and knowledge may assist in achieving convergence of concerns and expectations between both groups and may encourage producers to keep trying different strategies to control flystrike. These activities also provide the producers with an opportunity to gain experience engaging with the general public in a setting which is controlled and where they are supported by other industry representatives. To minimise the risks associated with these activities, careful considerations should be made during the recruitment process (of the public participants) and the sessions need to be coordinated and monitored by experienced facilitators. Three or four days after this activity, a meeting with the producer group should be coordinated. A brief online session should be organised by the group facilitator to discuss producers' views, experience, and remarks about this interaction with the public.

Structure:

Step 1. Group activity. Facilitated meeting sessions with members of the general public.



Step 2. Group activity. Three or four days later, online meeting with producers to discuss experience and remarks about interacting with the public.

6.4 Measuring the effectiveness of the extension strategy

A combination of quantitative and qualitative data can be used to assess the effectiveness of this strategy. Three key aspects should be evaluated:

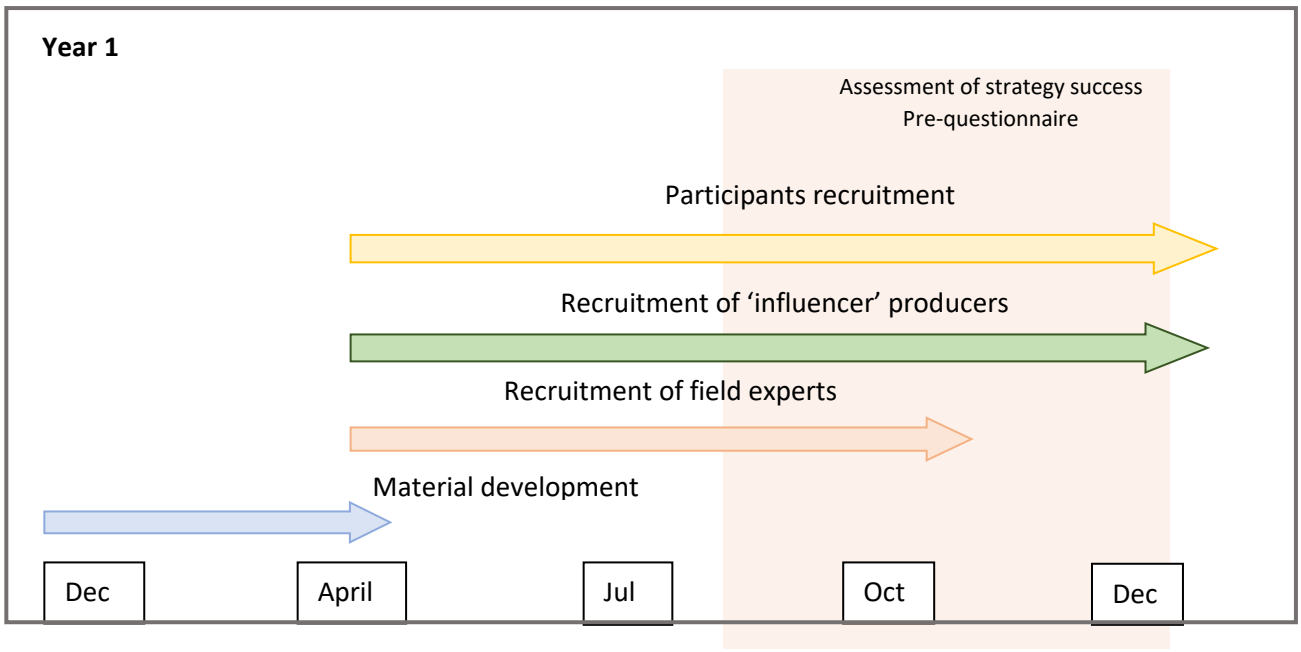
1) Actual uptake and intention to change. This can be measured during the on-farm visits in year 3 (see timeline below) and with follow-up visits/interviews with the producers, 6 and 12 months after their participation in the program. This should assess how many producers kept using the recommendations of the program and how many are thinking of transitioning (intention to) or have actually transitioned to non-mulesed operations. It is important to considered that a longitudinal intervention/extension program should be conducted, ideally 5 years or more, in order to effectively measure the effectiveness of this program.

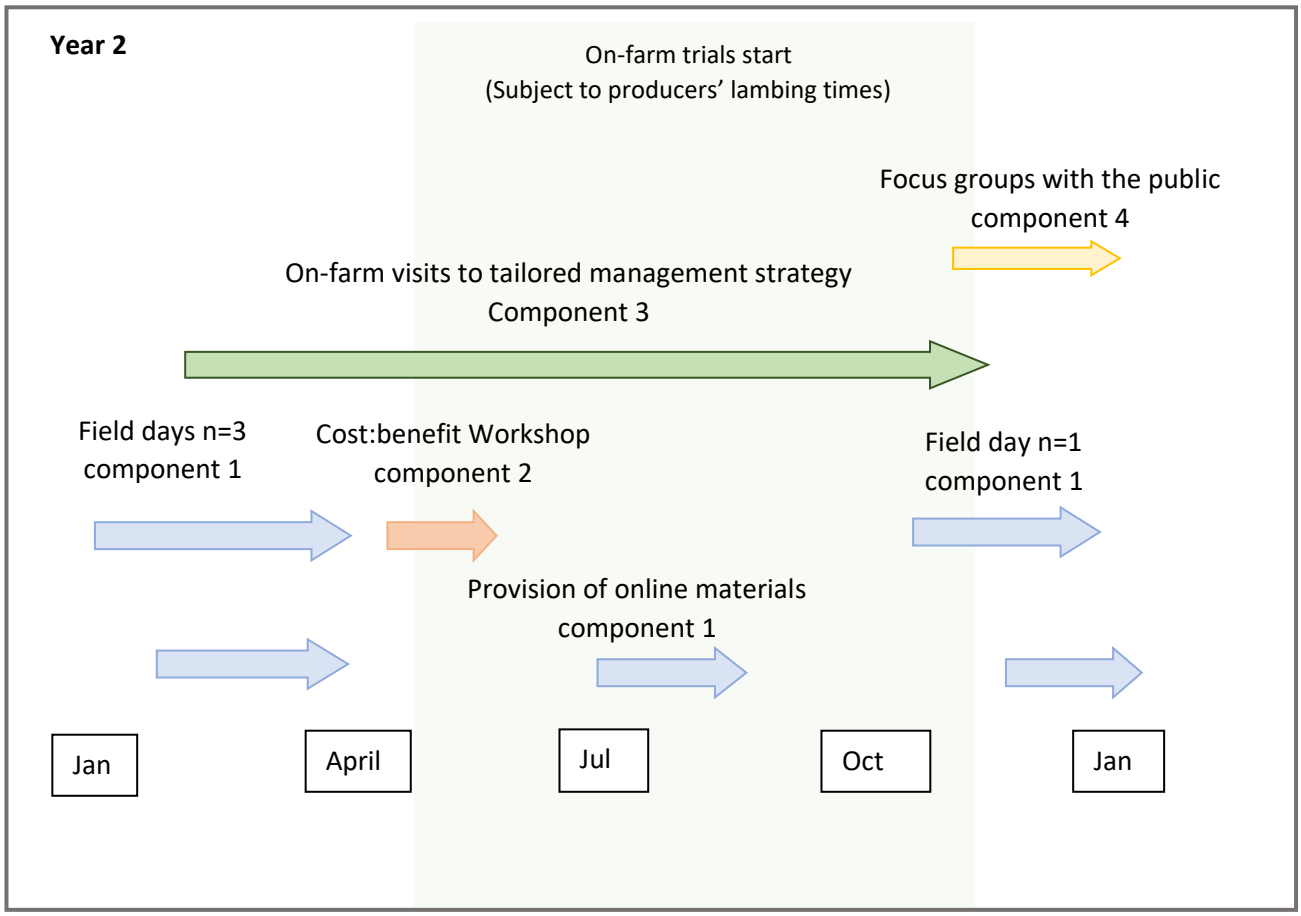
2) Changes in knowledge and attitudes. A pre- and post- short questionnaire should be developed to measure changes in knowledge and attitudes before and after their participation in this program, Also, short-term changes in knowledge should be assessed continuously throughout the program (one- or two-weeks after an activity concerning component 1).

3) Producers' experience and further participation. A series of face-to-face or phone interviews should be organised after the program to asked for producers' feedback. What work? What didn't work? Any recommendations and final remarks? Would they recommend this program to other participants?

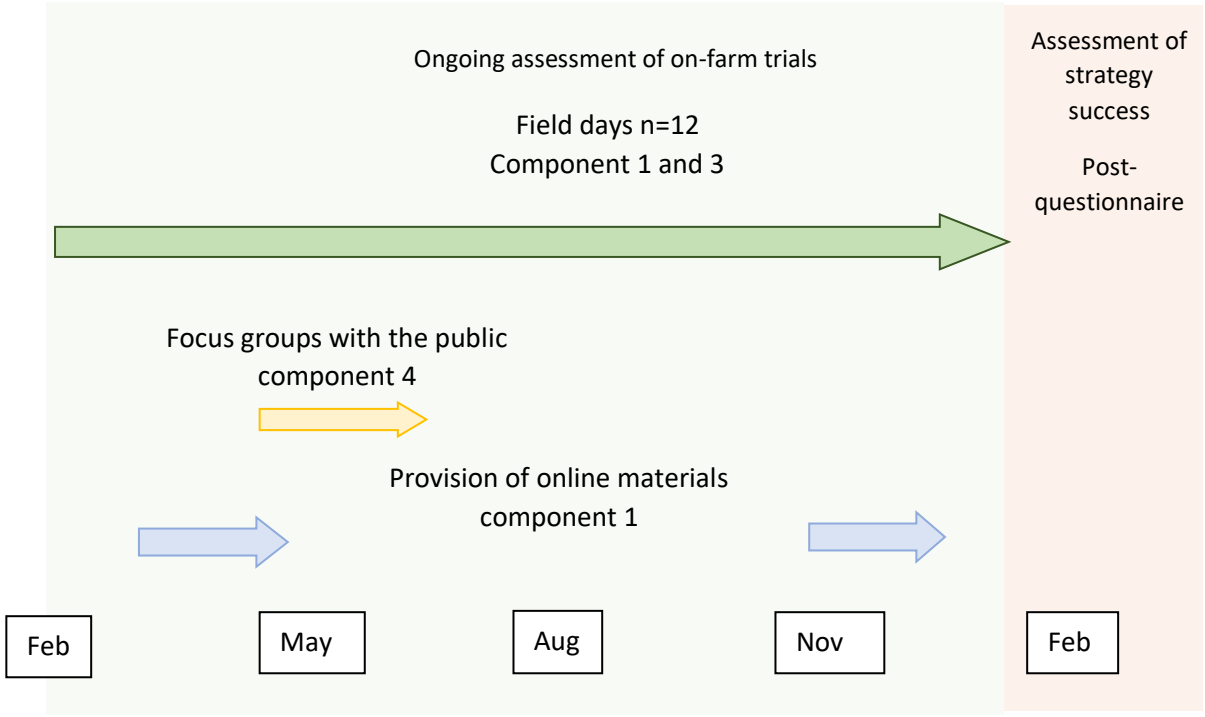
After participation in the program, producers that decided to transition to non-mulesed operations could become the 'influencers' in future producer groups, allowing a sustainable dissemination of the program.

6.5 Timeline


Year 1
Assessment of strategy success
Pre-questionnaire
Participants recruitment
Recruitment of 'influencer' producers
Recruitment of field experts
Material development
Dec
April
Jul
Oct
Dec


Year 2
On-farm trials start
(Subject to producers' lambing times)
Focus groups with the public
component 4
On-farm visits to tailored management strategy
Component 3
Field days n=3
component 1
Cost:benefit Workshop
component 2
Field day n=1
component 1
Provision of online materials
component 1
Jan
April
Jul
Oct
Jan

Year 3


Ongoing assessment of on-farm trials
Field days n=12
Component 1 and 3
Assessment of strategy success
Post-questionnaire
Focus groups with the public component 4
Provision of online materials component 1
Feb
May
Aug
Nov
Feb

7. Conclusion

This document reports on key findings from 1) the cost:benefit analysis, 2) the revision of the New Zealand experience with the cessation of mulesing, results from 3) a focus group, phone interviews (with producers and shearers), and a national survey on producers' management and attitudes. Based on all these results, a potential intervention/extension strategy to support farmers transition to non-mulesed operations was developed and reported here.

The cost: benefit analysis was developed as a producer 'tool'. This 'tool' will allow producers to populate a spreadsheet with their own, personalised data, or, in the instance where this is not available, enterprise- and rainfall-specific data can be utilised instead. The research team felt that due to the variability in enterprises across Australia that a producer tool was more appropriate, allowing a cost-benefit analysis to be completed to a specific enterprise type and operation. A series of sample models were run for both Prime Lamb and Merino enterprises across winter-dominant, summer-dominant and uniform rainfall areas. The assumptions used for these analyses were based on current on-farm management practices, findings from a producer survey that was developed for this component, and relevant literature when appropriate. Findings from these case scenarios indicated a positive cash flow (ranging from $0.33 to $2.19 per DSE, depending on rainfall areas) for Prime lamb enterprises transitioning to non-mulesing compared to continuing mulesing. Note that based on survey responses, there were no fleece or stock sale premiums included in these analyses. However, there is an opportunity for prime lamb producers to receive a premium on the price of non-mulesed wool if farms are certified with some programs (e.g., RWS and Authentico), and this would lead to additional financial benefits. Further, based on the survey results from Milestone 1, mulesed Prime Lamb flocks had a higher breech flystrike percentage than non-mulesed flocks. Whilst this is highly likely to be due to variation in management practices, genetics or other factors from survey respondents, it does indicate that Prime Lamb producers in winter rainfall regions of Australia may not experience substantial costs when transitioning to a non-mulesed enterprise if breech flystrike is well controlled, as the increased costs associated with the higher dag score and preventative chemical application are outweighed by the benefits of decreased breech strike prevalence and lack of mulesing costs. For Merino enterprises, the case scenarios modelled indicated a positive cash flow of $1.58 per DSE in winter rainfall areas (assuming a 6.6% wool premium over a 7-year period), and a negative cash flow of $-4.29 to $-9.08 per DSE in summer and uniform rainfall areas, respectively. Note that based on survey responses, only a 2% wool premium was applied to the scenario in summer rainfall zones, and no wool premium was applied to the model in uniform rainfall areas. Overall, results from the scenarios run through the cost: benefit analysis tool developed indicated that there is little cost to be incurred for Prime Lamb producers to shift to non-mulesing operations. This is consistent with respondents from the producer survey undertaken in Milestone 1 and 4, in which most Prime Lamb producers indicated that they are either "non-mulesing" or have "ceased mulesing". In contrast, Merino producers will incur in the highest costs of phasing out of mulesing, as is outlined in the analyses. However, the Merino wool industry is also the area which receives the greatest wool premiums for non-mulesed wool/not mulesing. Analyses indicate that Merino wool producers will require an ongoing non-mulesed wool premium of approximately 6.5-7% to break even with the costs of phasing out mulesing.

After reviewing the New Zealand experience, we learned that it took about 5 years of active and intense effort to phase out mulesing in New Zealand and this effort was largely industry-led. The industry achieved its aim in 2010 by using four key strategies (1) participation of key stakeholders, (2) market-based incentive to phase out mulesing (e.g., forward contracts), (3) by developing a research and extension program (exposing farmers to science-based strategies to decrease the risk of flystrike) and (4) by developing a certification scheme. The approach of the industry was not to advocate for ceasing mulesing but offering extra support and economic incentives to producers that decided not to mules their sheep. It should be acknowledged that due to the New Zealand Merino Company having approximately 75% market-share of wool purchased in New Zealand, their advocacy for ceasing mulesing was a key factor contributing to the phasing out of mulesing. This is different to the Australian situation, where there is (1) a larger Merino population and (2) a substantially higher number of wool buyers than in New Zealand. As a result, market share of individual wool buyers is substantially lower than that of the New Zealand Merino Company. While New Zealand has a much different wool industry, climate, different sheep and size of enterprises than Australia, the challenge of having a sustainable industry that can meet consumers' demands is not significantly different, and a number of lessons can still be learned from their experience.

In relation to producers' attitudes and barriers to adoption, the main findings indicated that producer attitudes towards mulesing are important drivers in the decision to run mulesed or non-mulesed operations. These attitudes comprise behavioural beliefs (the perceived importance/effectiveness of mulesing), normative beliefs (the perceived influence of other stakeholders), and control beliefs (the perceived ability or difficulty of phasing out mulesing). Overall, producers were more likely to run mulesed enterprises if they held more positive views in relation to the importance/effectiveness of mulesing (e.g. believe that mulesing is 'the key' to prevent flystrike), if they perceived a high incidence of breech flystrike, if they perceived a high risk of flystrike in their property, if they perceived that shearers and other farmers preferred mulesed sheep (e.g., mulesed sheep are easier to shear and crutch) and if they perceived that running non-mulesed enterprises is difficult (e.g. alternatives to mulesing are time consuming, expensive and affect profitability). In contrast, producers were more likely to run non-mulesed enterprises if they held more positive views about alternative strategies to control flystrike, if they perceived a low risk of flystrike in their property and low flystrike incidence, if they perceived that listening to consumers is important, and if they believed that the industry is at risk if mulesing is not phased out. In addition, other external factors such as economic incentives and rainfall were also seen as factors influencing, to some degree, the decision to run mulesed or non-mulesed operations. However, their contribution to the decision was smaller than attitudinal factors. While all attitudinal factors are important predictors, their level of contribution to the decision to run mulesed or non-mulesed enterprises slightly varied according to type of enterprise. For example, for meat-focused producers, behavioural beliefs (the perceived effectiveness of mulesing and low trust in other strategies to control flystrike) were important factors influencing the decision to run mulesed or non-mulesed operations. For meat-wool producers, control beliefs (the perceived ability or difficulty of phasing out mulesing) and other external factors such as economic incentives were main drivers. For mixed producers, control beliefs were key factors influencing the decision. For wool-focused producers, behavioural beliefs, control beliefs and external factors such as rainfall were important drivers for the continuation of mulesing.

Based on all these results, a potential intervention/extension strategy to support producers transition to non-mulesed operations was developed. The strategy was designed using a cognitive-behavioural intervention approach, and the aim is to facilitate a transition to non-mulesed operations by increasing knowledge of and trust in short- and long-term strategies to control flystrike, by discussing the cost and benefits associated to phase out mulesing, by trialling its on-farm practicality, and by raising awareness of the risks to social license. Thus, the proposed extension strategy consists of four main components 1) Improving knowledge of and trust in short- and long-term strategies to control flystrike, 2) Provision of tools for decision making, 3) Tailored on-farm trials to encourage the use of short- and long-term strategies to control flystrike and 4) Increasing communication with consumers. Now, it is important to consider that for an extension strategy/program to be effective, it needs to be conducted along with a broader industry approach. The sheep industry (wool and meat industries) should take a leadership role with a collaborative approach, leading and supporting the transition with a clear position/message and realistic short-term and long-term targets that can be embraced by key industry stakeholders. It is important for the industry to 1) work together with key industry stakeholders, 2) identify market benefits and risks (e.g., potential market access or penalties) and communicate these to relevant stakeholders, 3) support the transition to non-mulesed enterprises through extension programs, 4) support and fund research focused on developing and refining short-term and long-term strategies to manage flystrike and 5) elaborate an industry certification and/or labelling scheme. A combined effort, that is, working together with key stakeholders, understanding their opinions and concerns regarding phasing out mulesing, in a manner indicative of cooperation, can be an effective strategy to support a transition.

7.1 Benefits to industry

The outcomes of this project translate into two main practical applications:

1) The development of a producer ‘tool’ that can be use by sheep producers and their advisors. This allows producers to estimate their financial position following a phase out of mulesing over 7 years. This can encourage interaction and conversation between producer and their advisors. This producer ‘tool’ can also be integrated to extension programs (such as the one developed for this project) or integrated into existing extension material i.e., Flyboss or can sit alongside information prompting consideration and/or discussion of phasing out mulesing.
2) The development of an extension strategy that targets key producers’ attitudes and barriers to transition to non-mulesed operations. This extension strategy is based on the key findings of his project, was developed using a cognitive behavioural intervention approached, and it should be piloted in future studies to assess its effectiveness or alternatively, key aspects of this strategy (e.g., increase communication with consumers and awareness of social license risks) should be incorporated into existing extension programs/MLA producer demonstrations sites to support farmers with the transition.

8. Future research and recommendations

- A challenge in the cost:benefit analysis was in relation to flystrike prevalence data in mulesed and non-mulesed flocks, which was reported by producers. Survey data indicated that the prevalence of breech flystrike in non-mulesed flocks was lower than in mulesed flocks, while available literature, from 1976, reported significantly high breech flystrike prevalence in non-mulesed flocks with no preventative chemical treatment applied to the sheep in the study. It is recommended, therefore, that further studies assess the actual on-farm prevalence of breech flystrike of mulesed versus unmulesed sheep. Updated information on this key data could further support/inform extension programs.

- The natural next step of this project is to trial the intervention/extension strategy that has been developed as part of this project. A 3-year study with five or six producer groups should be conducted to assess the effectiveness of this strategy in supporting farmers transition to non-mulesed operations.

- Another important aspect to consider is public concerns and social license. Mulesing is one of the most controversial husbandry procedures in the Australian sheep industry, causing public scrutiny and risks to markets. Thus, further research should examine the market/consumer/public risks, both domestically and internationally, associated with mulesing being part of the lamb meat supply chain. Further data on consumer attitudes and risks to social license could further support/inform a strategy to transition to non-mulesed operations.

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10. Appendix

10.1 Cost:Benefit assumptions

10.1.1 Shearing cost assumptions

Crutching cost assumptions

	Crutching (cost/head)	
	At Sheds	Not at Sheds
Full crutching, no wigging or ringing	$1.14	$0.98
0.5 shed hands per crutcher	$0.30	$0.30
Total	**$1.44**	**$1.28**

10.1.2 Mulesing cost assumptions

Product (if relevant)	Cost of product	Volume (ml)	Dose Rate	Dose/lamb (ml)*	Product cost/lamb
Mulesing procedure	-	-	-	-	$1.10
Tri-solfen® applied to tail and mulesing wound	$600.00	5000	6ml/10 kg	6	$0.72
Tri-solfen® applied to tail only	$600.00	5000	1.5ml/10kg	1.5	$0.18
Buccalgesic® OTM (10mg/ml Meloxicam)	$66.00	200	1 ml/10 kg liveweight	1	$0.33
Meloxicam injectable (20mg/ml Meloxicam)	$90.00	100	1 ml/20 kg liveweight	0.5	$0.45

10.1.3 Chemical prevention cost assumptions

Product	Cost of Product	Volume (ml)	Dose Rate	Dose /DSE	Product cost/DSE	Total Cost incl. Labour @ $0.20 /DSE	Notes
Clik® (Dicyclanil 50g/L)	$904.55	20000	12ml	12	$0.54	$0.74	For prevention of breech strike only.
Clik-zin® (Dicyclanil 12.5g/L)	$590	20000	10ml per lamb		$0.30	$0.50	For prevention of breech strike.

Cyromazine Liquid (Cyromazine 500g/L)	$180	5000	6ml	6	$0.22	$0.42	Dose for sheep blowfly control. Assume 6ml per head (3L jetting fluid, diluted 200ml per 100L
Cyromazine Spray on (Cyromazine 60g/L)	$186	20000	66ml	66	$0.61	$0.81	Dose rate based on 8 months since shearing, prevention of body AND crutch strike
Blowfly & Lice Jetting Fluid® (Ivermectin 16g/L)	$480	20000	5ml	5	$0.12	$0.32	Dose for jetting prevention/ treatment of strike. 200ml/100L water, dose 2.5L per head

10.1.4 Cost of dag assumptions

	Dag score					
	0	**1**	**2**	**3**	**4**	**5**
Dag-weight (g/head)	68	115	204	380	737	1225
Wool yield (%)	36.4%	28.5%	22.9%	19.8%	13.6%	14.4%
Clean wool in crutchings (g/head)	25	33	47	75	100	176
Clean wool in crutchings ($/head)	$0.21	$0.27	$0.60	$0.97	$1.29	$2.28
Clean wool forgone compared with no dags ($/head)	$0.00	**$0.07**	**$0.40**	**$0.76**	**$1.09**	**$2.07**
Dagging labour cost ($/head)*	$0.10	$0.20	$0.30	$0.72	$0.90	$0.90
Additional dagging cost compared with no dags ($/head)	$0.00	**$0.10**	**$0.20**	**$0.62**	**$0.80**	**$0.80**
Larger crutch area non-mulesed c.f. mulesed sheep ($/head)	**$0.42**	**$0.42**	**$0.64**	**$0.64**	**$0.64**	**$0.64**

Direct cost of dags non-mulesed ($/head)	**$0.42**	**$0.59**	**$1.24**	**$2.03**	**$2.53**	**$3.51**
Direct cost of dags mulesed ($/head)	**$0.00**	**$0.17**	**$0.60**	**$1.38**	**$1.89**	**$2.87**
Micron Price Guide	1743					
% Discount of crutchings from ewes with dag score ≤ 1	48%					
% Discount of crutchings from ewes with dag score ≥ 2	74%					
Larger crutch volume per DSE for mulesed c.f. non-mulesed (grams)	50					

10.1.4 Flystrike rate table

Enterprise and Dominant Rainfall Type	% Breech Flystrike Mulesed	% Breech Flystrike Non-Mulesed
Merino: Winter Rainfall	0.6%	1.1%
Merino: Uniform Rainfall	1.0%	0.5%
Merino: Summer Rainfall	4.0%	0.5%
Prime Lamb: Winter Rainfall	3.0%	0.5%
Prime Lamb: Uniform Rainfall	2.5%	0.2%
Prime Lamb: Summer Rainfall	2.0%	1.0%

10.1.5 Chemical dose rate table

Category	Subcategory	Product (if relevant)	Cost of product	Volume (ml)	Dose Rate	Dose/DSE (ml)	Product Cost/DSE	Labour Cost/DSE	Total Cost/DSE	Notes
Treatment costs	Analgesia / anti-inflammatories	Buccalgesic® OTM (10mg/ml Meloxicam)	$98.00	200	1 ml/10 kg liveweight	5	$2.45	$0.25	$2.70	
		Meloxicam injectable (20mg/ml Meloxicam)	$95.00	100	1 ml/20 kg liveweight	2.5	$2.38	$1.00	$3.38	
	Antibiotics	Alamycin LA 300® (300mg/ml Oxytetracycline)	$180.00	500	1 ml/15 kg liveweight	3.3	$1.19	$1.00	$2.19	
		Oxytet-200 LA® (200mg/ml Oxytetracycline)	$40.00	100	1 ml/10 kg liveweight	5	$2.00	$1.00	$3.00	
	Flystrike Treatment	Extinosad® Eliminator (25g/L Spinosad)	$850.00	5000	1.5ml/head	1.5	$0.26	$2.50	$2.76	Note dose based on flystrike dressing. 5ml per 5L water,

										1.5L/hd
	Trimming wool (assume 5 minutes trimming/DSE)	Blowfly & Lice Jetting Fluid® (Ivermectin 16g/L) Trimming labour	$480 $30.00	20000 per hour	5ml	5	$0.12 $2.50	$2.50 $2.50	$2.62 $2.50	

** Labour Cost/DSE (assume 20 mins for treatment and trim)

10.1.6 Standard sale values

Stock Class	Merino	Prime Lamb
Ewes	$109.00	$169.00
Lambs	$98.00	$177.00
Weaners	$98.00	$177.00
Wethers	$109.00	$101.00
Rams	$71.00	$227.00

10.1.7 Standard DSE ratings

Stock Class	Merino	Prime Lamb
Ewes	1.5	2.2
Lambs*	0	0
Weaners	1	1.2
Wethers	1	1
Rams	2	2.5

10.2 Model outputs by Enterprise and Rainfall Distribution

10.2.1 Prime lamb: Winter-dominant Rainfall

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Mulesing Savings (No mulesing procedure costs, Tri-solfen savings etc.)	$3,276.00	$3,276.00	$3,357.90	$3,441.85	$3,527.89	$3,616.09	$3,706.49	$3,799.16
Non-mulesing wool premium (%)***	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Non-mulesing stock sales premium (%)***	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Additional Shearing Costs	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional crutching	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional chemical use	$3,701.98	$3,701.98	$3,794.53	$3,889.40	$3,986.63	$4,086.30	$4,188.46	$4,293.17
Wool loss from increased dag score and larger crutch area	$1,042.90	$1,042.90	$1,068.98	$1,095.70	$1,123.09	$1,151.17	$1,179.95	$1,209.45
Wool loss from tender wool (low staple strength) discounts **(Assuming 50% of struck sheep have tender wool (Colditz 2005))**	-$85.94	-$85.94	-$88.09	-$90.29	-$92.55	-$94.86	-$97.23	-$99.66
Wool loss from reduced fleece weight for struck sheep **(Assuming fleece weights are 5% lighter for struck sheep (Colditz 2005; Broadmeadow 1983; Raadsma 1983)**	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional cost of treating individual animals with breech flystrike in unmulesed enterprise	-$4,921.54	-$4,921.54	-$5,044.58	-$5,170.69	-$5,299.96	-$5,432.46	-$5,568.27	-$5,707.48
TOTAL COST OF NON-MULESING (if value is negative, there is no cost to non-mulesing, rather additional savings are made)	-$3,538.59	-$3,538.59	-$3,627.05	-$3,717.73	-$3,810.67	-$3,905.94	-$4,003.59	-$4,103.68
Additional income from non-mulesing (wool sale premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00

Additional income from non-mulesing (stock sale premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income from non-mulesing (liveweight premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income minus Total Costs	$3,538.59	$3,538.59	$3,627.05	$3,717.73	$3,810.67	$3,905.94	$4,003.59	$4,103.68
RESULT PRESENTED ON A PER DSE BASIS	**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**
Total cost of non-mulesing per DSE (if value is negative, there is no cost to non-mulesing, rather additional savings are made)	-$0.32	-$0.32	-$0.33	-$0.34	-$0.35	-$0.35	-$0.36	-$0.37
Additional income per DSE from non-mulesing (wool and stock sale premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income minus Total Costs per DSE	$0.32	$0.32	$0.33	$0.34	$0.35	$0.35	$0.36	$0.37
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**NPV**
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing	$3,538.59	$3,627.05	$3,717.73	$3,810.67	$3,905.94	$4,003.59	$4,103.68	$24,165.98
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing (per DSE)	$0.32	$0.33	$0.34	$0.35	$0.35	$0.36	$0.37	$2.19

10.2.2 Merino: Winter-dominant rainfall

	Year 0	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**
Mulesing Savings (No mulesing procedure costs, Tri-solfen savings etc.)	$5,187.00	$5,187.00	$5,316.68	$5,449.59	$5,585.83	$5,725.48	$5,868.61	$6,015.33
Non-mulesing wool premium (%)***	6.6%	6.6%	5.5%	4.4%	3.2%	2.1%	1.0%	0.0%

Non-mulesing stock sales premium (%)***	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Additional Shearing Costs	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional crutching	$6,589.88	$6,589.88	$6,754.63	$6,923.49	$7,096.58	$7,274.00	$7,455.85	$7,642.24
Additional chemical use	$3,885.44	$3,885.44	$3,982.58	$4,082.14	$4,184.19	$4,288.80	$4,396.02	$4,505.92
Wool loss from increased dag score and larger crutch area	$14,461.23	$14,461.23	$14,822.76	$15,193.33	$15,573.16	$15,962.49	$16,361.55	$16,770.59
Wool loss from tender wool (low staple strength) discounts **(Assuming 50% of struck sheep have tender wool (Colditz 2005))**	$92.31	$92.31	$94.62	$96.99	$99.41	$101.90	$104.44	$107.06
Wool loss from reduced fleece weight for struck sheep **(Assuming fleece weights are 5% lighter for struck sheep (Colditz 2005; Broadmeadow 1983; Raadsma 1983)**	$40.91	$40.91	$41.94	$42.99	$44.06	$45.16	$46.29	$47.45
Additional cost of treating individual animals with breech flystrike in unmulesed enterprise	$613.37	$613.37	$628.70	$644.42	$660.53	$677.04	$693.97	$711.32
TOTAL COST OF NON-MULESING (if value is negative, there is no cost to non-mulesing, rather additional savings are made)	$20,496.14	$20,496.14	$21,008.55	$21,533.76	$22,072.10	$22,623.91	$23,189.50	$23,769.24
Additional income from non-mulesing (wool sale premiums or discounts)	$24,370.71	$24,370.71	$20,227.69	$13,350.28	$6,541.64	$2,093.32	$314.00	$0.00
Additional income from non-mulesing (stock sale premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income from non-mulesing (liveweight premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00

Additional income minus Total Costs	$3,874.57	$3,874.57	-$780.85	-$8,183.48	-$15,530.47	-$20,530.58	-$22,875.51	-$23,769.24
RESULT PRESENTED ON A PER DSE BASIS	**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**
Total cost of non-mulesing per DSE (if value is negative, there is no cost to non-mulesing, rather additional savings are made)	$2.19	$2.19	$2.25	$2.31	$2.36	$2.42	$2.48	$2.54
Additional income per DSE from non-mulesing (wool and stock sale premiums or discounts)	$2.61	$2.61	$2.17	$1.43	$0.70	$0.22	$0.03	$0.00
Additional income minus Total Costs per DSE	$0.41	$0.41	-$0.08	-$0.88	-$1.66	-$2.20	-$2.45	-$2.54
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**NPV**
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing	$3,874.57	-$780.85	-$8,183.48	-$15,530.47	-$20,530.58	-$22,875.51	-$23,769.24	-$76,499.93
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing (per DSE)	$0.41	-$0.08	-$0.88	-$1.66	-$2.20	-$2.45	-$2.54	-$8.19

10.2.3 Prime Lamb: Uniform Rainfall

	Year 0	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**
Mulesing Savings (No mulesing procedure costs, Tri-solfen savings etc.)	$3,276.00	$3,276.00	$3,357.90	$3,441.85	$3,527.89	$3,616.09	$3,706.49	$3,799.16
Non-mulesing wool premium (%)***	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Non-mulesing stock sales premium (%)***	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Additional Shearing Costs	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional crutching	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional chemical use	$3,701.98	$3,701.98	$3,794.53	$3,889.40	$3,986.63	$4,086.30	$4,188.46	$4,293.17
Wool loss from increased dag score and larger crutch area	$1,042.90	$1,042.90	$1,068.98	$1,095.70	$1,123.09	$1,151.17	$1,179.95	$1,209.45
Wool loss from tender wool (low staple strength) discounts **(Assuming 50% of struck sheep have tender wool (Colditz 2005))**	-$79.06	-$79.06	-$81.04	-$83.07	-$85.14	-$87.27	-$89.45	-$91.69
Wool loss from reduced fleece weight for struck sheep **(Assuming fleece weights are 5% lighter for struck sheep (Colditz 2005; Broadmeadow 1983; Raadsma 1983)**	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional cost of treating individual animals with breech flystrike in unmulesed enterprise	-$4,527.82	-$4,527.82	-$4,641.01	-$4,757.04	-$4,875.96	-$4,997.86	-$5,122.81	-$5,250.88
TOTAL COST OF NON-MULESING (if value is negative, there is no cost to non-mulesing, rather additional savings are made)	-$3,137.99	-$3,137.99	-$3,216.44	-$3,296.85	-$3,379.27	-$3,463.76	-$3,550.35	-$3,639.11
Additional income from non-mulesing (wool sale premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income from non-mulesing (stock sale premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income from non-mulesing (liveweight premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income minus Total Costs	$3,137.99	$3,137.99	$3,216.44	$3,296.85	$3,379.27	$3,463.76	$3,550.35	$3,639.11
RESULT PRESENTED ON A PER DSE BASIS	**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**

Total cost of non-mulesing per DSE (if value is negative, there is no cost to non-mulesing, rather additional savings are made)	-$0.28	-$0.28	-$0.29	-$0.30	-$0.31	-$0.31	-$0.32	-$0.33
Additional income per DSE from non-mulesing (wool and stock sale premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income minus Total Costs per DSE	$0.28	$0.28	$0.29	$0.30	$0.31	$0.31	$0.32	$0.33
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**NPV**
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing	$3,137.99	$3,216.44	$3,296.85	$3,379.27	$3,463.76	$3,550.35	$3,639.11	$21,430.19
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing (per DSE)	$0.28	$0.29	$0.30	$0.31	$0.31	$0.32	$0.33	$1.94

10.2.4 Merino: Uniform Rainfall

	Year 0	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**
Mulesing Savings (No mulesing procedure costs, Tri-solfen savings etc.)	$5,187.00	$5,187.00	$5,316.68	$5,449.59	$5,585.83	$5,725.48	$5,868.61	$6,015.33
Non-mulesing wool premium (%)***	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Non-mulesing stock sales premium (%)***	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Additional Shearing Costs	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional crutching	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional chemical use	$3,885.44	$3,885.44	$3,982.58	$4,082.14	$4,184.19	$4,288.80	$4,396.02	$4,505.92
Wool loss from increased dag score and larger crutch area	$14,461.23	$14,461.23	$14,822.76	$15,193.33	$15,573.16	$15,962.49	$16,361.55	$16,770.59

Wool loss from tender wool (low staple strength) discounts **(Assuming 50% of struck sheep have tender wool (Colditz 2005))**	-$92.31	-$92.31	-$94.62	-$96.99	-$99.41	-$101.90	-$104.44	-$107.06
Wool loss from reduced fleece weight for struck sheep **(Assuming fleece weights are 5% lighter for struck sheep (Colditz 2005; Broadmeadow 1983; Raadsma 1983)**	-$40.91	-$40.91	-$41.94	-$42.99	-$44.06	-$45.16	-$46.29	-$47.45
Additional cost of treating individual animals with breech flystrike in unmulesed enterprise	-$613.37	-$613.37	-$628.70	-$644.42	-$660.53	-$677.04	-$693.97	-$711.32
TOTAL COST OF NON-MULESING (if value is negative, there is no cost to non-mulesing, rather additional savings are made)	$12,413.07	$12,413.07	$12,723.40	$13,041.49	$13,367.52	$13,701.71	$14,044.25	$14,395.36
Additional income from non-mulesing (wool sale premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income from non-mulesing (stock sale premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income from non-mulesing (liveweight premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income minus Total Costs	-$12,413.07	-$12,413.07	-$12,723.40	-$13,041.49	-$13,367.52	-$13,701.71	-$14,044.25	-$14,395.36
RESULT PRESENTED ON A PER DSE BASIS	**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**
Total cost of non-mulesing per DSE (if value is negative, there is no cost to	$1.33	$1.33	$1.36	$1.40	$1.43	$1.47	$1.50	$1.54

non-mulesing, rather additional savings are made)								
Additional income per DSE from non-mulesing (wool and stock sale premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income minus Total Costs per DSE	-$1.33	-$1.33	-$1.36	-$1.40	-$1.43	-$1.47	-$1.50	-$1.54
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**NPV**
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing	-$12,413.07	-$12,723.40	-$13,041.49	-$13,367.52	-$13,701.71	-$14,044.25	-$14,395.36	-$84,772.21
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing (per DSE)	-$1.33	-$1.36	-$1.40	-$1.43	-$1.47	-$1.50	-$1.54	-$9.08

10.2.5 Prime Lamb: Summer-dominant Rainfall

	Year 0	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**
Mulesing Savings (No mulesing procedure costs, Tri-solfen savings etc.)	$3,276.00	$3,276.00	$3,357.90	$3,441.85	$3,527.89	$3,616.09	$3,706.49	$3,799.16
Non-mulesing wool premium (%)***	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Non-mulesing stock sales premium (%)***	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Additional Shearing Costs	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional crutching	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional chemical use	$3,701.98	$3,701.98	$3,794.53	$3,889.40	$3,986.63	$4,086.30	$4,188.46	$4,293.17
Wool loss from increased dag score and larger crutch area	$1,042.90	$1,042.90	$1,068.98	$1,095.70	$1,123.09	$1,151.17	$1,179.95	$1,209.45

Wool loss from tender wool (low staple strength) discounts **(Assuming 50% of struck sheep have tender wool (Colditz 2005))**	-$34.38	-$34.38	-$35.23	-$36.12	-$37.02	-$37.94	-$38.89	-$39.86
Wool loss from reduced fleece weight for struck sheep **(Assuming fleece weights are 5% lighter for struck sheep (Colditz 2005; Broadmeadow 1983; Raadsma 1983)**	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional cost of treating individual animals with breech flystrike in unmulesed enterprise	-$1,968.62	-$1,968.62	-$2,017.83	-$2,068.28	-$2,119.98	-$2,172.98	-$2,227.31	-$2,282.99
TOTAL COST OF NON-MULESING (if value is negative, there is no cost to non-mulesing, rather additional savings are made)	-$534.10	-$534.10	-$547.46	-$561.14	-$575.17	-$589.55	-$604.29	-$619.40
Additional income from non-mulesing (wool sale premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income from non-mulesing (stock sale premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income from non-mulesing (liveweight premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income minus Total Costs	$534.10	$534.10	$547.46	$561.14	$575.17	$589.55	$604.29	$619.40
RESULT PRESENTED ON A PER DSE BASIS	**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**
Total cost of non-mulesing per DSE (if value is negative, there is no cost to non-mulesing, rather additional savings are made)	-$0.05	-$0.05	-$0.05	-$0.05	-$0.05	-$0.05	-$0.05	-$0.06
Additional income per DSE from non-mulesing (wool and stock sale premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income minus Total Costs per DSE	$0.05	$0.05	$0.05	$0.05	$0.05	$0.05	$0.05	$0.06

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	NPV
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing	$534.10	$547.46	$561.14	$575.17	$589.55	$604.29	$619.40	$3,647.54
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing (per DSE)	$0.05	$0.05	$0.05	$0.05	$0.05	$0.05	$0.06	$0.33

10.2.6 Merino: Summer-Dominant Rainfall

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Mulesing Savings (No mulesing procedure costs, Tri-solfen savings etc.)	$6,127.50	$6,127.50	$6,280.69	$6,437.70	$6,598.65	$6,763.61	$6,932.70	$7,106.02
Non-mulesing wool premium (%)***	2.0%	2.0%	1.7%	1.3%	1.0%	0.6%	0.3%	0.0%
Non-mulesing stock sales premium (%)***	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Additional Shearing Costs	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional crutching	$6,589.88	$6,589.88	$6,754.63	$6,923.49	$7,096.58	$7,274.00	$7,455.85	$7,642.24
Additional chemical use	$2,988.80	$2,988.80	$3,063.52	$3,140.11	$3,218.61	$3,299.08	$3,381.55	$3,466.09
Wool loss from increased dag score and larger crutch area	$14,461.23	$14,461.23	$14,822.76	$15,193.33	$15,573.16	$15,962.49	$16,361.55	$16,770.59
Wool loss from tender wool (low staple strength) discounts **(Assuming 50% of struck sheep have tender wool (Colditz 2005))**	-$646.19	-$646.19	-$662.35	-$678.91	-$695.88	-$713.28	-$731.11	-$749.39
Wool loss from reduced fleece weight for struck sheep **(Assuming fleece weights are 5% lighter for struck sheep (Colditz 2005; Broadmeadow 1983; Raadsma 1983)**	-$286.40	-$286.40	-$293.56	-$300.90	-$308.42	-$316.13	-$324.04	-$332.14

Additional cost of treating individual animals with breech flystrike in unmulesed enterprise	-$4,293.56	-$4,293.56	-$4,400.90	-$4,510.92	-$4,623.69	-$4,739.29	-$4,857.77	-$4,979.21
TOTAL COST OF NON-MULESING (if value is negative, there is no cost to non-mulesing, rather additional savings are made)	$12,686.26	$12,686.26	$13,003.41	$13,328.50	$13,661.71	$14,003.25	$14,353.33	$14,712.17
Additional income from non-mulesing (wool sale premiums or discounts)	$7,385.06	$7,385.06	$6,129.60	$4,045.54	$1,982.31	$634.34	$95.15	$0.00
Additional income from non-mulesing (stock sale premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income from non-mulesing (liveweight premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income minus Total Costs	-$5,301.19	-$5,301.19	-$6,873.81	-$9,282.96	-$11,679.40	-$13,368.91	-$14,258.18	-$14,712.17
RESULT PRESENTED ON A PER DSE BASIS	**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**
Total cost of non-mulesing per DSE (if value is negative, there is no cost to non-mulesing, rather additional savings are made)	$1.36	$1.36	$1.39	$1.43	$1.46	$1.50	$1.54	$1.58
Additional income per DSE from non-mulesing (wool and stock sale premiums or discounts)	$0.79	$0.79	$0.66	$0.43	$0.21	$0.07	$0.01	$0.00
Additional income minus Total Costs per DSE	-$0.57	-$0.57	-$0.74	-$0.99	-$1.25	-$1.43	-$1.53	-$1.58
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**NPV**

Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing	-$5,301.19	-$6,873.81	-$9,282.96	-$11,679.40	-$13,368.91	-$14,258.18	-$14,712.17	-$67,403.38
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing (per DSE)	-$0.57	-$0.74	-$0.99	-$1.25	-$1.43	-$1.53	-$1.58	-$7.22

10.3 Scenarios run using breech strike prevalence from other literature

10.3.1 Prime lamb: winter rainfall (Corriedales – based on Reid & Jones, 1976)

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Mulesing Savings (No mulesing procedure costs, Tri-solfen savings etc.)	$3,276.00	$3,276.00	$3,357.90	$3,441.85	$3,527.89	$3,616.09	$3,706.49	$3,799.16
Non-mulesing wool premium (%)***	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Non-mulesing stock sales premium (%)***	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Additional Shearing Costs	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional crutching	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional chemical use	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Wool loss from increased dag score and larger crutch area	$1,042.90	$1,042.90	$1,068.98	$1,095.70	$1,123.09	$1,151.17	$1,179.95	$1,209.45
Wool loss from tender wool (low staple strength) discounts **(Assuming 50% of struck sheep have tender wool (Colditz 2005))**	$1,175.63	$1,175.63	$1,205.02	$1,235.14	$1,266.02	$1,297.67	$1,330.12	$1,363.37

Wool loss from reduced fleece weight for struck sheep **(Assuming fleece weights are 5% lighter for struck sheep (Colditz 2005; Broadmeadow 1983; Raadsma 1983)**	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional cost of treating individual animals with breech flystrike in unmulesed enterprise	$67,326.67	$67,326.67	$69,009.83	$70,735.08	$72,503.45	$74,316.04	$76,173.94	$78,078.29
TOTAL COST OF NON-MULESING (if value is negative, there is no cost to non-mulesing, rather additional savings are made)	$66,269.20	$66,269.20	$67,925.93	$69,624.08	$71,364.68	$73,148.79	$74,977.51	$76,851.95
Additional income from non-mulesing (wool sale premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income from non-mulesing (stock sale premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income from non-mulesing (liveweight premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income minus Total Costs	-$66,269.20	-$66,269.20	-$67,925.93	-$69,624.08	-$71,364.68	-$73,148.79	-$74,977.51	-$76,851.95
RESULT PRESENTED ON A PER DSE BASIS	**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**
Total cost of non-mulesing per DSE (if value is negative, there is no cost to non-mulesing, rather additional savings are made)	$6.01	$6.01	$6.16	$6.32	$6.47	$6.64	$6.80	$6.97

Additional income per DSE from non-mulesing (wool and stock sale premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income minus Total Costs per DSE	-$6.01	-$6.01	-$6.16	-$6.32	-$6.47	-$6.64	-$6.80	-$6.97
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**NPV**
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing	-$66,269.20	-$67,925.93	-$69,624.08	-$71,364.68	-$73,148.79	-$74,977.51	-$76,851.95	-$452,570.13
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing (per DSE)	-$6.01	-$6.16	-$6.32	-$6.47	-$6.64	-$6.80	-$6.97	-$41.06

3.3.2 Prime lamb: winter rainfall (crossbreds – based on Reid & Jones, 1976)

	Year 0	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**
Mulesing Savings (No mulesing procedure costs, Tri-solfen savings etc.)	$3,276.00	$3,276.00	$3,357.90	$3,441.85	$3,527.89	$3,616.09	$3,706.49	$3,799.16
Non-mulesing wool premium (%)***	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Non-mulesing stock sales premium (%)***	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Additional Shearing Costs	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional crutching	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional chemical use	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Wool loss from increased dag score and larger crutch area	$1,042.90	$1,042.90	$1,068.98	$1,095.70	$1,123.09	$1,151.17	$1,179.95	$1,209.45

Wool loss from tender wool (low staple strength) discounts **(Assuming 50% of struck sheep have tender wool (Colditz 2005))**	$609.13	$609.13	$624.35	$639.96	$655.96	$672.36	$689.17	$706.40
Wool loss from reduced fleece weight for struck sheep **(Assuming fleece weights are 5% lighter for struck sheep (Colditz 2005; Broadmeadow 1983; Raadsma 1983)**	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional cost of treating individual animals with breech flystrike in unmulesed enterprise	$34,883.87	$34,883.87	$35,755.97	$36,649.87	$37,566.12	$38,505.27	$39,467.90	$40,454.60
TOTAL COST OF NON-MULESING (if value is negative, there is no cost to non-mulesing, rather additional savings are made)	$33,259.90	$33,259.90	$34,091.40	$34,943.69	$35,817.28	$36,712.71	$37,630.53	$38,571.29
Additional income from non-mulesing (wool sale premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income from non-mulesing (stock sale premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income from non-mulesing (liveweight premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income minus Total Costs	-$33,259.90	-$33,259.90	-$34,091.40	-$34,943.69	-$35,817.28	-$36,712.71	-$37,630.53	-$38,571.29
RESULT PRESENTED ON A PER DSE BASIS	**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**

Total cost of non-mulesing per DSE (if value is negative, there is no cost to non-mulesing, rather additional savings are made)	$3.02	$3.02	$3.09	$3.17	$3.25	$3.33	$3.41	$3.50
Additional income per DSE from non-mulesing (wool and stock sale premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income minus Total Costs per DSE	-$3.02	-$3.02	-$3.09	-$3.17	-$3.25	-$3.33	-$3.41	-$3.50
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**NPV**
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing	-$33,259.90	-$34,091.40	-$34,943.69	-$35,817.28	-$36,712.71	-$37,630.53	-$38,571.29	-$227,140.81
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing (per DSE)	-$3.02	-$3.09	-$3.17	-$3.25	-$3.33	-$3.41	-$3.50	-$20.61

10.3.3 Merino: Winter-Dominant Rainfall Period 1 (based on Tyrell (2013))

	Year 0	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**
Mulesing Savings (No mulesing procedure costs, Tri-solfen savings etc.)	$5,187.00	$5,187.00	$5,316.68	$5,449.59	$5,585.83	$5,725.48	$5,868.61	$6,015.33
Non-mulesing wool premium (%)***	6.6%	6.6%	5.5%	4.4%	3.2%	2.1%	1.0%	0.0%
Non-mulesing stock sales premium (%)***	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Additional Shearing Costs	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional crutching	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional chemical use	$3,885.44	$3,885.44	$3,982.58	$4,082.14	$4,184.19	$4,288.80	$4,396.02	$4,505.92

Wool loss from increased dag score and larger crutch area	$11,133.00	$11,133.00	$11,411.32	$11,696.61	$11,989.02	$12,288.75	$12,595.97	$12,910.86
Wool loss from tender wool (low staple strength) discounts **(Assuming 50% of struck sheep have tender wool (Colditz 2005))**	-$406.18	-$406.18	-$416.33	-$426.74	-$437.41	-$448.35	-$459.55	-$471.04
Wool loss from reduced fleece weight for struck sheep **(Assuming fleece weights are 5% lighter for struck sheep (Colditz 2005; Broadmeadow 1983; Raadsma 1983)**	-$180.02	-$180.02	-$184.52	-$189.14	-$193.87	-$198.71	-$203.68	-$208.77
Additional cost of treating individual animals with breech flystrike in unmulesed enterprise	-$2,698.81	-$2,698.81	-$2,766.28	-$2,835.44	-$2,906.32	-$2,978.98	-$3,053.45	-$3,129.79
TOTAL COST OF NON-MULESING (if value is negative, there is no cost to non-mulesing, rather additional savings are made)	$6,546.43	$6,546.43	$6,710.09	$6,877.84	$7,049.79	$7,226.03	$7,406.68	$7,591.85
Additional income from non-mulesing (wool sale premiums or discounts)	$24,370.71	$24,370.71	$20,227.69	$13,350.28	$6,541.64	$2,093.32	$314.00	$0.00
Additional income from non-mulesing (stock sale premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income from non-mulesing (liveweight premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income minus Total Costs	$17,824.29	$17,824.29	$13,517.60	$6,472.44	-$508.15	-$5,132.71	-$7,092.68	-$7,591.85
RESULT PRESENTED ON A PER DSE BASIS	**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**
Total cost of non-mulesing per DSE (if value is negative, there is no cost to non-mulesing, rather additional savings are made)	$0.70	$0.70	$0.72	$0.74	$0.75	$0.77	$0.79	$0.81

Additional income per DSE from non-mulesing (wool and stock sale premiums or discounts)	$2.61	$2.61	$2.17	$1.43	$0.70	$0.22	$0.03	$0.00
Additional income minus Total Costs per DSE	$1.91	$1.91	$1.45	$0.69	-$0.05	-$0.55	-$0.76	-$0.81
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**NPV**
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing	$17,824.29	$13,517.60	$6,472.44	-$508.15	-$5,132.71	-$7,092.68	-$7,591.85	$18,766.42
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing (per DSE)	$1.91	$1.45	$0.69	-$0.05	-$0.55	-$0.76	-$0.81	$2.01

10.3.4 Merino: Winter-Dominant Rainfall Period 2 (based on Tyrell (2013))

	Year 0	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**
Mulesing Savings (No mulesing procedure costs, Tri-solfen savings etc.)	$5,187.00	$5,187.00	$5,316.68	$5,449.59	$5,585.83	$5,725.48	$5,868.61	$6,015.33
Non-mulesing wool premium (%)***	6.6%	6.6%	5.5%	4.4%	3.2%	2.1%	1.0%	0.0%
Non-mulesing stock sales premium (%)***	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Additional Shearing Costs	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional crutching	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional chemical use	$3,885.44	$3,885.44	$3,982.58	$4,082.14	$4,184.19	$4,288.80	$4,396.02	$4,505.92
Wool loss from increased dag score and larger crutch area	$8,339.18	$8,339.18	$8,547.66	$8,761.35	$8,980.38	$9,204.89	$9,435.02	$9,670.89
Wool loss from tender wool (low staple strength) discounts **(Assuming 50% of struck sheep have tender wool (Colditz 2005))**	$129.24	$129.24	$132.47	$135.78	$139.18	$142.66	$146.22	$149.88
Wool loss from reduced fleece weight for struck sheep **(Assuming fleece weights are**	$57.28	$57.28	$58.71	$60.18	$61.68	$63.23	$64.81	$66.43

5% lighter for struck sheep (Colditz 2005; Broadmeadow 1983; Raadsma 1983)								
Additional cost of treating individual animals with breech flystrike in unmulesed enterprise	$858.71	$858.71	$880.18	$902.18	$924.74	$947.86	$971.55	$995.84
TOTAL COST OF NON-MULESING (if value is negative, there is no cost to non-mulesing, rather additional savings are made)	$8,082.85	$8,082.85	$8,284.92	$8,492.05	$8,704.35	$8,921.95	$9,145.00	$9,373.63
Additional income from non-mulesing (wool sale premiums or discounts)	$24,370.71	$24,370.71	$20,227.69	$13,350.28	$6,541.64	$2,093.32	$314.00	$0.00
Additional income from non-mulesing (stock sale premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income from non-mulesing (liveweight premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income minus Total Costs	$16,287.86	$16,287.86	$11,942.77	$4,858.23	-$2,162.71	-$6,828.63	-$8,831.01	-$9,373.63
RESULT PRESENTED ON A PER DSE BASIS	**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**
Total cost of non-mulesing per DSE (if value is negative, there is no cost to non-mulesing, rather additional savings are made)	$0.87	$0.87	$0.89	$0.91	$0.93	$0.96	$0.98	$1.00
Additional income per DSE from non-mulesing (wool and stock sale premiums or discounts)	$2.61	$2.61	$2.17	$1.43	$0.70	$0.22	$0.03	$0.00
Additional income minus Total Costs per DSE	$1.74	$1.74	$1.28	$0.52	-$0.23	-$0.73	-$0.95	-$1.00
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**NPV**
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing	$16,287.86	$11,942.77	$4,858.23	-$2,162.71	-$6,828.63	-$8,831.01	-$9,373.63	$8,273.77

Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing (per DSE)	$1.74	$1.28	$0.52	-$0.23	-$0.73	-$0.95	-$1.00	$0.89

10.3.5 Merino: Uniform Rainfall Period 1 (based on Tyrell (2013))

	Year 0	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**
Mulesing Savings (No mulesing procedure costs, Tri-solfen savings etc.)	$5,187.00	$5,187.00	$5,316.68	$5,449.59	$5,585.83	$5,725.48	$5,868.61	$6,015.33
Non-mulesing wool premium (%)***	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Non-mulesing stock sales premium (%)***	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Additional Shearing Costs	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional crutching	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional chemical use	$3,885.44	$3,885.44	$3,982.58	$4,082.14	$4,184.19	$4,288.80	$4,396.02	$4,505.92
Wool loss from increased dag score and larger crutch area	$8,914.22	$8,914.22	$9,137.08	$9,365.51	$9,599.64	$9,839.64	$10,085.63	$10,337.77
Wool loss from tender wool (low staple strength) discounts **(Assuming 50% of struck sheep have tender wool (Colditz 2005))**	-$313.87	-$313.87	-$321.71	-$329.75	-$338.00	-$346.45	-$355.11	-$363.99
Wool loss from reduced fleece weight for struck sheep **(Assuming fleece weights are 5% lighter for struck sheep (Colditz 2005; Broadmeadow 1983; Raadsma 1983)**	-$139.11	-$139.11	-$142.59	-$146.15	-$149.81	-$153.55	-$157.39	-$161.32
Additional cost of treating individual animals with breech flystrike in unmulesed enterprise	-$2,085.44	-$2,085.44	-$2,137.58	-$2,191.02	-$2,245.79	-$2,301.94	-$2,359.49	-$2,418.47
TOTAL COST OF NON-MULESING (if value is negative, there is no cost to non-mulesing, rather additional savings are made)	$5,074.25	$5,074.25	$5,201.10	$5,331.13	$5,464.41	$5,601.02	$5,741.04	$5,884.57

Additional income from non-mulesing (wool sale premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income from non-mulesing (stock sale premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income from non-mulesing (liveweight premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income minus Total Costs	-$5,074.25	-$5,074.25	-$5,201.10	-$5,331.13	-$5,464.41	-$5,601.02	-$5,741.04	-$5,884.57
RESULT PRESENTED ON A PER DSE BASIS	**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**
Total cost of non-mulesing per DSE (if value is negative, there is no cost to non-mulesing, rather additional savings are made)	$0.54	$0.54	$0.56	$0.57	$0.59	$0.60	$0.61	$0.63
Additional income per DSE from non-mulesing (wool and stock sale premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income minus Total Costs per DSE	-$0.54	-$0.54	-$0.56	-$0.57	-$0.59	-$0.60	-$0.61	-$0.63
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**NPV**
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing	-$5,074.25	-$5,201.10	-$5,331.13	-$5,464.41	-$5,601.02	-$5,741.04	-$5,884.57	-$34,653.39
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing (per DSE)	-$0.54	-$0.56	-$0.57	-$0.59	-$0.60	-$0.61	-$0.63	-$3.71

10.3.6 Merino: Uniform Rainfall Period 2 (based on Tyrell (2013))

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Mulesing Savings (No mulesing procedure costs, Tri-solfen savings etc.)	$5,187.00	$5,187.00	$5,316.68	$5,449.59	$5,585.83	$5,725.48	$5,868.61	$6,015.33
Non-mulesing wool premium (%)***	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Non-mulesing stock sales premium (%)***	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Additional Shearing Costs	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional crutching	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional chemical use	$3,885.44	$3,885.44	$3,982.58	$4,082.14	$4,184.19	$4,288.80	$4,396.02	$4,505.92
Wool loss from increased dag score and larger crutch area	$8,914.22	$8,914.22	$9,137.08	$9,365.51	$9,599.64	$9,839.64	$10,085.63	$10,337.77
Wool loss from tender wool (low staple strength) discounts **(Assuming 50% of struck sheep have tender wool (Colditz 2005))**	-$313.87	-$313.87	-$321.71	-$329.75	-$338.00	-$346.45	-$355.11	-$363.99
Wool loss from reduced fleece weight for struck sheep **(Assuming fleece weights are 5% lighter for struck sheep (Colditz 2005; Broadmeadow 1983; Raadsma 1983)**	-$139.11	-$139.11	-$142.59	-$146.15	-$149.81	-$153.55	-$157.39	-$161.32
Additional cost of treating individual animals with breech flystrike in unmulesed enterprise	-$2,085.44	-$2,085.44	-$2,137.58	-$2,191.02	-$2,245.79	-$2,301.94	-$2,359.49	-$2,418.47
TOTAL COST OF NON-MULESING (if value is negative, there is no cost to non-mulesing, rather additional savings are made)	$5,074.25	$5,074.25	$5,201.10	$5,331.13	$5,464.41	$5,601.02	$5,741.04	$5,884.57
Additional income from non-mulesing (wool sale premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income from non-mulesing (stock sale premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00

Additional income from non-mulesing (liveweight premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income minus Total Costs	-$5,074.25	-$5,074.25	-$5,201.10	-$5,331.13	-$5,464.41	-$5,601.02	-$5,741.04	-$5,884.57
RESULT PRESENTED ON A PER DSE BASIS	**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**
Total cost of non-mulesing per DSE (if value is negative, there is no cost to non-mulesing, rather additional savings are made)	$0.54	$0.54	$0.56	$0.57	$0.59	$0.60	$0.61	$0.63
Additional income per DSE from non-mulesing (wool and stock sale premiums or discounts)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Additional income minus Total Costs per DSE	-$0.54	-$0.54	-$0.56	-$0.57	-$0.59	-$0.60	-$0.61	-$0.63
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**NPV**
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing	-$5,074.25	-$5,201.10	-$5,331.13	-$5,464.41	-$5,601.02	-$5,741.04	-$5,884.57	-$34,653.39
Difference in cash flow for an enterprise transitioning to non-mulesing compared to continuing mulesing (per DSE)	-$0.54	-$0.56	-$0.57	-$0.59	-$0.60	-$0.61	-$0.63	-$3.71

10.4 Focus group agenda

Aim

Identify farmers' salient behavioural, normative and control beliefs about ceasing to have mulesed sheep in the Australian sheepmeat industry and identify salient beliefs about adopting alternative breech strike prevention methods.

Time	Topic
Introduction 5-min	Welcome - Explain the purpose of the focus group discussion: • To collect qualitative information on farmer attitudes towards ceasing to have mulesed sheep in the Australian sheepmeat industry and perceived barriers towards mulesing-free systems • Explain the reason for taping: For noting important points post-meeting Request participants to read the explanatory statement and complete consent form.
Round table Introductions 5-min	Break the ice • Each person will take turns in giving a brief introduction of themselves • Demographic information: flock size, years of experience, etc.
General discussion 40-min	We would like to ask you some general questions about mulesing and flystrike prevention in the Australian sheep industry, with special focus on the sheepmeat industry. **aim:** Identify farmers' salient behavioural, normative and control beliefs about ceasing to have mulesed sheep in the Australian sheepmeat industry and identify salient beliefs about adopting alternative breech strike prevention methods. **General questions about:** Behavioural beliefs (how important/relevant) to mules or not to mules? • *How much are you affected by flystrike in this area?* • *In your opinion, what is the best prevention method for flystrike? Why?* • *Do you have mulesed sheep on your property? If yes, Do you mules them? or do you buy them mulesed?* • *If you buy them, do you have to pay more for mulesed sheep?* • *If you have stopped buying mulesed sheep, why did you stop? What management changes were made?* • *If you have stopped mulesing, why did you stop? What management changes were made? For example, have you changed your lambs' tail length?* • *How necessary is mulesing for ease of shearing and crutching? Does the tail have any impact on shearing or crutching? If so, what about it?* • *Are there any benefits of ceasing to have mulesed sheep in the sheepmeat industry?* Subjective norms • *Do you think it is common to have mulesed sheep in the sheepmeat industry? Yes, no? Why?* • *What do you think farmers think about ceasing to have mulesed sheep in the sheepmeat industry? Do you agree or disagree? Why?* • *Who do you think will oppose to this? Do you think shearers would agree?* • *Has anyone had comments from shearers/crutchers about their sheep? E.g. mulesed vs non mulesed. Or comments about tail length?* • *Has anyone changed anything they do because of comments shearers have made? What about comments from stock agents?* • *What do you think about NZ banning mulesing?* Control beliefs

	• *In your opinion, what do you think would be difficult about ceasing to have mulesed sheep in the Australian sheepmeat industry?* • *Do you think it is possible in the short or long-term? Why?*
Wind up and thank you – 5 min	- Brief wrap up

10.5 Attitudinal Survey

Flystrike Prevention in the Sheep Industry
-SURVEY-

This 25-min survey contains questions about flystrike prevention and mulesing. The survey is confidential and anonymous. This MLA funded study is being conducted by Dr Carolina Munoz, DrRebecca Doyle, Ms Madeleine Woodruff, Prof Andrew Fisher and Prof Grahame Coleman at the University of Melbourne Faculty of Veterinary and Agricultural Sciences.

All data will be kept securely in the Faculty of Veterinary and Agricultural Sciences for five years fromthe date of publication before being destroyed.

Participation in this study is completely voluntary and you are free to withdraw at any stage of the survey.

If you have any questions, please contact:
Carolina Munoz
Faculty of Veterinary and
Agricultural SciencesEmail:
munoz.c@unimelb.edu.au

This project has been approved by the University of Melbourne Ethics Committee. Should you have anyconcerns about the conduct of the project, you are welcome to contact the Executive Officer, Human Research Ethics, The University of Melbourne, on telephone: 03 8344 2073 or fax: 03 9347 6739

Instructions

Please answer all questions to the best of your ability. If you do not know the answer to a question, please give us your best estimate or leave them blank. There are no "right" or "wrong" answers to any of the questions, just answer what is true for you. Your individual responses will remain strictly confidential. Only summary results for the entire sample will be used.

This next section contains questions about your farm.

1. What is the address postcode of your farm?_____
   (If you have more than one property, please complete one survey per property).

2. What is your annual average rainfall? *(mm)* _____

3. What is your predominant rainfall period?
   ☐ Summer rainfall ☐ Winter rainfall ☐ Uniform rainfall

4. What is your main farming enterprise?
   ☐ Meat-focused enterprise ☐ Meat-wool enterprise ☐ Wool-focused enterprise
   ☐ Mixed production, *please specify* _____

5. How long have you farmed sheep? *(Years)* _____

6. How many head of sheep do you **currently** own?

	Ewes	Wethers	Weaners	Rams
1st cross ewes				
2nd cross ewes				
Prime lambs				
Merino				

7. Including leased land, what is your total grazing area allocated to sheep production? *(approx. in hectares)*_____

8. How many people work on the farm? *(Including yourself, family members and employees)* _____

9. How often is the flock normally 'supervised' (i.e. check over/visually assess) throughout the year (outside lambing)?
   ☐ Daily ☐ Twice weekly ☐ Weekly ☐ Fortnightly ☐ Monthly ☐ Never
   ☐ Other_____

10. How would you rate the risk of flystrike in your area? *(mark with an X)*

No risk at all (1)	2	3	4	Very High risk (5)

11. Please estimate the incidence of flystrike (occurrence or frequency) in **your mature flock** in years with either low, medium orhigh levels of flystrike.

Complete this table for your mulesed stock.

	Breech Strike *% affected*	Body Strike *% affected*	Poll Strike *% affected*	Pizzle Strike *% affected*
Years with **high** levels of flystrike				
Years with **medium** levels of flystrike				
Years with **low** levels of flystrike				

Complete this table for your non-mulesed stock.

	Breech Strike *% affected*	Body Strike *% affected*	Poll Strike *% affected*	Pizzle Strike *% affected*
Years with **high** levels of flystrike				
Years with **medium** levels of flystrike				
Years with **low** levels of flystrike				

12. For each management practice below, please rate its importance in your operation in relation to flystrike prevention

	Very unimportant	Unimportant	Neither important nor unimportant	Important	Very important
Mulesing					
Tail docking					
First crutching					
Second crutching					
Shearing					
Chemical prevention of breech flystrike					
Nutritional management					
Genetics					
Other, please specify					

13. What do you do in response to flystrike in individual sheep? *(select all that apply)*

☐ Chemical Treatment ☐ Trim wool ☐ Antibiotics

☐ Anti-inflamatories *(please specify)* _____

☐ Other *(please specify)* _____

14. What do you do in response to flystrike for mob/flock-based treatment? *(select all that apply)*

☐ Chemical Treatment ☐ Bring forward crutching ☐ Bring forward shearing

☐ Other *(please specify)* _____

15. What is the approximate percentage (%) of a mob affected with flystrike which will drive you to treat the entire mob (as opposed toindividual treatment)? _____

16. Do you (or your contractor) currently mules lambs?

☐ Yes ☐ Sometimes ☐ No, I have never mulesed my stock No, but

☐ I have in past. *Please give details on when:* _____

16a. If yes or sometimes, who performs this procedure on the farm? _____

16b. If yes or sometimes, what percentage of lambs are mulesed? _____

16c. If yes or sometimes, are wether lambs mulesed?

☐ Yes ☐ Sometimes ☐ No

16d. If yes or sometimes, is any form of local anaesthesia or pain relief given at mulesing?

☐ Yes ☐ Sometimes ☐ No

If yes or sometimes, please specify the pain relief used: _____

17. Do you mules or use a method of breech modification? *(please select all that apply, otherwise leave blank)*

	Mules	Tail strip only	Clips	Breech freeze branding
1st cross ewes				
2nd cross ewes				
Prime lambs				
Merino				

18. Please indicate which image best depicts the length at which you (or your contractor) dock your lambs' tails *(mark with an X)*

A

☐

B

☐

C

☐

19. How important is it to dock tails at the length you choose (as specified above)?

☐ Very Important ☐ Important ☐ Neither unimportant nor important ☐ Unimportant ☐ Very Unimportant

20. What tail docking method do you (or your contractor) use?

☐ Rubber rings ☐ Hot knife ☐ Other, please specify _____

21. Who usually docks tails on your farm?

☐ Myself ☐ A helper *(farm staff/family member)* ☐ A contractor ☐ Other, please specify _____

22. Is there a recommended tail docking length?

☐ Yes ☐ No ☐ Not Aware

22a. If yes, what is the recommended tail docking length? _____

23. How important is it to dock tails at the recommended length?

☐ Very Important ☐ Important ☐ Neither unimportant nor important ☐ Unimportant ☐ Very Unimportant

24. If you currently mules, what is the main reason for mulesing?

☐ High incidence of breech strike ☐ High fly risk area ☐ Cost of extra crutching

☐ There is no good alternative to mulesing ☐ Tried ceasing mulesing but unsuccessful

☐ Other, please specify _____

25. Do you make purchasing decisions based on whether or not a mob has been mulesed?

☐ Yes ☐ Sometimes ☐ No

26. If you have no mulesed stock, or have recently ceased mulesing on your property, what is the main reason for not mulesing? Price premium

☐ on lamb ☐ Price premium on wool ☐ Low fly risk ☐ Cost of mulesing ☐ Animal welfare concerns

☐ Other, please specify _____

27. If you have no mulesed stock, what do you do for flystrike prevention? _____

_____

_____

_____

_____

28. If you are phasing out mulesing or have ceased mulesing, how difficult was the transition to a mulesing-free operation?

☐ Very easy ☐ Easy ☐ Neither easy nor difficult ☐ Difficult ☐ Very difficult

29. If you are phasing out mulesing or have ceased mulesing, what were your main management changes? _____

_____

_____

30. If you are phasing out mulesing or have ceased mulesing, did you get advice or support with the transition?

☐ Yes ☐ No

30a. If yes, please specify the source of the advice: _____

31. If you have no mulesed stock, what are your main challenges for flystrike prevention? *(try to list them in order of priority)*

_____

_____

_____

_____

32. If you are phasing out mulesing or have ceased mulesing, have you changed tail docking length to compensate?
(e.g. make them longer, or shorter?)

☐ Yes ☐ No ☐ I'm not sure

32a. If yes, how? _____

_____

33. Please indicate which image best depicts the length at which you (or your contractor) PREVIOUSLY docked your lambs' tails while youwere still mulesing *(mark with an X)*

A B C

☐

☐

☐

34. What do you think is the main reason why farmers do not phase out mulesing? *Please rank them in order of priority*

☐ There is no better alternative ☐ Labour ☐ Cost ☐ Lack of time

☐ Not enough information ☐ Not validated research ☐ No market incentive/premium Other,

☐ please specify _____

35. Have you seen any material on how to phase out mulesing?

☐ Yes ☐ No ☐ Not aware

30a. If yes, please specify the source of the advice: _____

36. For each statement below, please **select** the option on the scale that most closely represents your level of **agreement** or **disagreement** with each statement.

	Strongly disagree	Disagree	Neither agree nor diagree	Agree	Strongly agree
Mulesing is the most effective method to prevent flystrike					
Mulesed sheep are less at risk of flystrike					
I would pay more for mulesed sheep					
Mulesing is needed if you farm sheep					
Mulesing is painful for sheep					
Mulesing has long-term animal welfare benefits					
There are currently no better alternatives to mulesing					
Most Australian farmers have mulesed sheep					
Alternatives to mulesing are expensive					
Unmulesed sheep need more chemicals to prevent breech flystrike					
There is not enough information about strategies to phase out mulesing					

37. For each statement below, please **select** the option on the scale that most closely represents your level of **agreement** or **disagreement** with each statement.

	Strongly disagree	Disagree	Neither agree nor diagree	Agree	Strongly agree
The industry is at risk if mulesing is not phased out					
I think the industry should phase out mulesing					
A lot of farmers would stop farming sheep if mulesing is phased out in Australia					
The public doesn't support mulesing					
I think that most farmers are not prepared to phase out mulesing					
Farmers need to listen to consumers					
I think the industry needs to educate the public about mulesing					
Shearers prefer mulesed sheep					
Shearers prefer short docked tails					
Tails the same length as the vulva make crutching difficult					
Tails the same length as the vulva make shearing difficult					
Shearers charge more for unmulesed sheep					

38. For each statement below, please **select** the option on the scale that most closely represents your level of **agreement** or **disagreement** with each statement.

	Strongly disagree	Disagree	Neither agree nor diagree	Agree	Strongly agree
I feel/felt prepared to phase out mulesing					
It was/would be difficult for me to phase out mulesing					
If mulesing is phased out, I will not farm sheep					
I can't see the economic benefits in phasing out mulesing					
It is difficult to get shearers if you have unmulesed sheep					
I would phase out mulesing if there is an economic benefit					
It is difficult to crutch unmulesed sheep					
It is difficult to shear unmulesed sheep					
I don't know what the best approach is to phase out mulesing on my property					
I don't know what the best approach is to prevent flystrike on my property					

39. Who would you seek advice from about flystrike prevention methods? *(tick all that apply)*

	Never	Rarely	Occasionally	Frequently	Very Frequent
Veterinarians					
Other farmers					
Closest family members *(e.g. spouse, parents, siblings, etc.)*					
Industry body *(e.g. MLA/AWI)*					
Friends					
Farm consultant					
Stock agent					
Shearers					
Other (please specify)					

40. To what extent do you **approve** or **disapprove** of the following procedures/practices carried out on sheep?

	Strongly diassaprove 1	2	3	4	Strongly approve 5
Mulesing					
Tail docking					
Clips					
Tail-strip					
Breech freeze branding					
Chemical prevention of breech flystrike					
Use of pain relief					

This section contains questions about you.

41. What is your Gender?

☐ Male ☐ Female ☐ Other/Prefer not to say

42. What is your age?

☐ 18-24

☐ 25 - 34

☐ 35 - 44

☐ 45 - 54

☐ 55 - 64

☐ 65 and over

43. What is your highest level of education?

☐ No Formal Schooling

☐ Primary School

☐ Secondary School

☐ Technical

☐ University or other higher educational institution

☐ Other educational institution, please specify _____

☐ Don't wish to answer

Thank you for completing this survey!

44. Any additional comments?

_____

_____

_____

_____

_____

Please provide your contact details if you wish to get a summary of the main findings of this study.

_____

Would you like to be contacted for a follow-up

10.6 Attitudinal Survey – Further results

General overview of survey respondents

A total of 546 respondents filled out the survey to a level of completion where the results could be utilised in the project. Table 2 outlines the distribution and percentage of respondents for each state. Note that the respondents were heavily concentrated across south-eastern Australia, consistent with the distribution and population density of sheep in Australia.

Table 2. Distribution of respondents to the attitudinal survey by state.

State	Number of respondents	Percentage of respondents (%)
NSW	157	28.8
VIC	153	28.0
SA	109	20.0
WA	78	14.3
TAS	23	4.8
QLD	26	4.2
Total respondents	**546**	**100**

Demographics

Most of the survey respondents were males (88.4%), over 45 years old and the most common highest level of education was university or higher degree followed by secondary school and technical education (Table 3). The level of experience with farming sheep was variable, ranging from 2 years to 70+ years (mean 36).

Table 3. Demographic information of survey participants

Age	Proportion of respondents (%)
18-24	0.4 (2)
25-34	4.7 (25)
35-44	10.6 (57)
45-54	21.2 (114)
55-64	32.2 (173)
65 and over	30.9 (166)
Total respondents	**100** (537)
Gender	
Male	88.4 (472)
Female	11.4 (61)
Other/Prefer not to say	0.2 (1)

Total respondents	**100** (534)
Education	**Proportion of respondents (%)**
Primary school	1.3 (7)
Secondary school	31.2 (167)
Technical or further educational institution (including TAFE collage)	28.9 (155)
University or other higher educational institution	34.7 (186)
Other educational institution	1.9 (10)
Don't wish to answer	2.1 (11)
Total respondents	**100** (536)

Total responses varied from 546 as some survey participants did not complete all questions in the survey.

Type of enterprise and rainfall pattern

Tables 4 and 5 show survey respondents by enterprise type and rainfall patterns. The majority of the respondents described themselves as meat-wool producers (44.5%), followed by mixed producers (26.9%), which were usually classed as crop and sheep producers or beef and sheep producers. A total of 14.7% of respondents were primarily prime lamb producers and 13.7% were wool growers. There was also significant variation in farm size as flock sizes ranged from 100 to 23,000 breeding ewes. Regardless of enterprise type, the majority of the respondents were from winter rainfall zones. It is likely that a biased response rate from high rainfall zones may have been influenced by the risk of flystrike (or the perceived risk) in these regions compared to those in the traditional "sheep-wheat belt" and pastoral areas of Australia.

Table 4. Percentage of respondents according to enterprise type.

Enterprise type	Frequency of respondents	Percentage of respondents (%)
Meat-focused enterprise	80	14.7
Meat-wool enterprise	242	44.5
Wool-focused enterprise	75	13.7
Mixed production	147	26.9
Total respondents	**544**	**100**

Total responses varied from 546 as some survey participants did not complete all questions in the survey.

Table 5. Percentage (%) and frequency (in parentheses) of respondents according to enterprise type and rainfall pattern.

Type of enterprise	Rainfall			Total
	Winter rainfall	Uniform rainfall	Summer rainfall	
Meat-focused enterprise	72.5 (58)	21.3 (17)	6.3 (5)	(80)
Meat-wool enterprise	68.5 (165)	19.9 (48)	11.6 (28)	(241)
Wool-focused enterprise	55.4 (41)	25.7 (19)	18.9 (14)	(74)
Mixed production	72.6 (106)	23.3 (34)	4.1 (6)	(146)
Total respondents	**370**	**118**	**53**	**541**

Total responses varied from 546 as some survey participants did not complete all questions in the survey.

4.2.2 Mulesing and type of enterprise and rainfall pattern

Similar to the phone interview results, there was an even spread between producers that have mulesed operations (56.2%) and mulesed-free operations (43.8%), results are presented in Table 6. Mulesing occurred across all type of enterprises, but it was significantly less common in meat-focused operations ($X^2_{(12, N = 542)} = 153$, $p = .000$, Table 7). Only 13.9% of meat producers reported to have mulesed enterprises, while 67.6% of meat-wool producers, 63.9% of wool growers and 57.2% of mixed producers self-reported to run mulesed operations. Most of these producers hired contractors to perform the procedure or mules themselves, and only a small percentage (0.7%) have mulesed enterprises solely because they had purchased mulesed sheep. It is worth considering that the survey targeted sheepmeat producers, and this may have led to the relatively low number of wool-focused enterprises in the sample.

Table 6. Percentage (%) and frequency (in parentheses) of participants that either mules or ceased mulesing (n= 545).

Do you (or you contractor) currently mules your lambs?	Proportion of respondents (%)
Yes	52.8 (288)
Sometimes	2.7 (15)
Bought mulesed	0.7 (4)
No, but I have in the past	20.5 (111)
No, I have never mulesed my stock	23.3 (127)
Total respondents	**100** (545)

Total responses varied from 546 as some survey participants did not complete all questions in the survey.

Table 7. Percentage (%) and frequency (in parentheses) of participants that either mules or ceased mulesing according to type of enterprise.

Do you (or your contractor) currently mules lambs?	Type of enterprise			
	Meat-focused	Meat-wool	Wool-focused	Mixed
Yes	8.9 (7)	65.1 (157)	61.3 (46)	52.4 (77)
Sometimes	2.5 (2)	2.5 (6)	1.3 (1)	4.1 (6)
I do not, but buy mulesed	2.5 (2)	0.0 (0)	1.3 (1)	0.7 (1)
No, but I have in the past	13.9 (11)	16.2 (39)	32.0 (24)	24.5 (36)
Never	72.2 (57)	16.2 (39)	4.0 (3)	18.4 (27)
Total respondents	**100** (79)	**100** (241)	**100** (75)	**100** (147)

Total responses varied from 546 as some survey participants did not complete all questions in the survey.

Location and perceived risk of flystrike are factors likely to influence the decision to have mulesed or non-mulesed operations. Results presented in Table 8 showed that there tended to be more

mulesed operations located in winter-predominant rainfall zones ($X^2_{(8, N=542)} = 15.3$, p=0.052). Analyses also disclosed a weak but significant negative relationship between perceived risk of flystrike and non-mulesed operations (Table 9), indicating that farmers that perceived a low risk of flystrike in their area/property are more likely to run mulesed-free enterprises (r= -0.126 p=0.005, and $X^2_{(12, N=495)} = 21.7$, p=0.04).

Table 8. Percentage (%) and frequency (in parentheses) of participants that either mules or ceased mulesing according to rainfall pattern (n= 542).

Do you (or your contractor) currently mules lambs?	What is your predominant rainfall period?		
	Winter rainfall	Uniform rainfall	Summer rainfall
Yes	54.2 (200)	55.0 (66)	37.7 (20)
Sometimes	3.3 (12)	2.5 (3)	0.0 (0)
Bought mulesed	0.3 (1)	1.7 (2)	1.9 (1)
No, but I have in the past	18.2 (67)	20.0 (24)	35.8 (19)
Never	24.1 (89)	20.8 (25)	24.5 (13)
Total respondents	**100** (369)	**100** (120)	**100** (53)

Total responses varied from 546 as some survey participants did not complete all questions in the survey.

Table 9. Percentage (%) and frequency (in parentheses) of participants that either mules or ceased mulesing according to perceived risk of flystrike (n= 495).

how would you rate the risk of flystrike in your area?	Do you (or your contractor) currently mules lambs?		Total
	Yes/Sometimes/buy mulesed	No, but I have in the past/Never	
1 (very low risk)	41.7 (15)	58.3 (21)	36
2	41.3 (31)	58.7 (44)	75
3 (moderate risk)	61.9 (78)	38.1 (48)	126
4	57.9 (81)	42.1 (59)	140
5 (very high risk)	60.2 (71)	39.8 (47)	118
Total respondents	**55.8** (276)	**44.2** (219)	**495**

Farmer attitudes and its influence on mulesed and non-mulesed operations

The attitudinal statements data were further analysed using Principal Component Analysis (PCA) followed by an Oblimin rotation to identify commonalities amongst the survey items. Principal Component Analysis is a technique that reduces a set number of variables (e.g. survey attitudinal statements) to a small number of new variables, known as principal components. Obtaining these new small set of variables, allows further analyses such as correlations and regressions.

The PCA analyses summarised the statements in the survey in four main components/groups. Scales for these components are obtained by calculating an average of the item scores in each component. Scale reliabilities were measured using Cronbach's α coefficients with an α >=0.70 as the criterion for acceptable reliability (DeVellis, 2003). Items were included in a scale if their loading on the relevant component exceeded 0.33 (Tabachnick & Fidell, 2012). Items were recoded where appropriate so that high scores reflected high agreement with the survey items. The first component was called 'behavioural beliefs,' which contained items that reflected beliefs in relation to the effectiveness/importance of the mulesing procedure (Table 15). The next component was called 'normative beliefs' and were divided to reflect beliefs about I) shearers and other farmers preferences (Table 16) and II) the influence of consumers (Table 17). The fourth component was called 'control beliefs,' which included beliefs surrounding the difficulty of phasing out mulesing, as presented in Table 18.

Table 15. Items included in the component 'behavioural beliefs'

Behavioural beliefs The perceived effectiveness of mulesing	**Component Matrix- Attitudinal statements in the survey**	**Cronbach's Alpha**	**Loadings**
	Mulesing is the most effective method to prevent flystrike	0.89	0.909
	There are currently no better alternatives to mulesing		0.854
	I would pay more for mulesed sheep		0.850
	Mulesing has long-term animal welfare benefits		0.833
	Mulesed sheep are less at risk of flystrike		0.825
	Unmulesed sheep need more chemicals to prevent breech flystrike		0.807
	Mulesing is needed if you farm sheep		0.788

Table 16. Items included in the component 'normative beliefs I'

Normative beliefs I The influence of shearers and other farmers	**Component Matrix - Attitudinal**	**Cronbach's Alpha**	**Loadings**
	Shearers prefer mulesed sheep	0.65	0.794
	A lot of farmers would stop farming sheep if mulesing were phased out in Australia		0.705
	Most Australian farmers have mulesed sheep		0.631
	Shearers charge more for unmulesed sheep		0.536

Table 17. Items included in the component 'normative beliefs II'

Normative beliefs II The influence of consumers	**Component Matrix - Attitudinal statements in the survey**	**Cronbach's Alpha**	**Loadings**
	Farmers need to listen to consumers	0.76	0.837
	The industry is at risk if mulesing is not phased out		0.805

	I think the industry should phase out mulesing		0.719

Table 18. Items included in the component 'control beliefs'

Control beliefs	Component Matrix - Attitudinal statements in the survey	Cronbach's Alpha	Loadings
The perceived difficulty of phasing out mulesing	It is difficult to crutch unmulesed sheep	0.84	0.881
	It is difficult to shear unmulesed sheep		0.875
	It was/would be difficult for me to phase out mulesing		0.782
	I don't feel prepared to phased out mulesing		0.683
	Alternatives to mulesing are expensive		0.661

With these new set of variables (Table 15-18), we examined relationships between the components (which reflected behavioural beliefs, normative beliefs, and control beliefs) and producers' decision to run mulesed or mulesed-free operations. Moderate positive relationships were disclosed between the decision to run mulesed-free operations and 'the influence of consumers,' suggesting that producers that perceived that listening to consumers is important and that the industry is at risk if mulesing is not phased out, were more likely to run mulesed-free operations. In contrast, there were moderate negative relationships between the decision to run mulesed-free operations and 'behavioural beliefs,' 'the influence of shearers and other farmers' and 'the perceived difficulty of phasing out mulesing.' These results indicate that producers were less likely to run mulesed-free enterprises if they had more positive views in relation to the effectiveness of mulesing, perceived that shearers and other farmers hold negative views in relation to unmulesed sheep and perceived that running mulesing-free enterprises is difficult. Results are presented in Table 19.

Table 19. Pearson correlations between attitudinal components and the decision to run mulesed-free operations, flock size and rainfall.

Survey Components		Mulesed-free operations	Head of sheep	Rainfall (mm)
Behavioural beliefs	Pearson	**-.501****	.032	-.074
The perceived effectiveness of mulesing	Sig.	**<0.001**	.477	.097
	N	**504**	505	497
Normative beliefs I	Pearson	**-.389****	.045	-.065
The influence of shearers and other farmers	Sig.	**<0.001**	.307	.143
	N	**520**	521	512
Normative beliefs II	Pearson	**.382****	-.068	**.096***
The influence of consumers	Sig.	**<0.001**	.117	**.028**
	N	**528**	529	**520**

Control beliefs	Pearson	**-.569****	.046	**-.099***
The perceived difficulty of phasing out mulesing	Sig.	**<0.001**	.298	**.027**
	N	**506**	507	**500**

Variable: Mulesed-free operations (score 1 = mules, score 2= mules sometimes, score 3= buy mulesed, score 4= I don't mules, but I have in the past, score 5= I have never mulesed my stock).

Table 20 presents results of correlation analyses between attitudinal components and approval of mulesing, the perceived risk of flystrike and levels of flock monitoring. Not surprisingly, there were strong positive correlations between behavioural beliefs and the levels of approval of mulesing as a method of flystrike prevention (r= 0.72, p= <0.001) and the perceived difficulty of phasing out mulesing (r= 0.65, p= <0.001). In line with results reported in Table 19, there were strong negative relationships between the perceived influence of consumers and approval of mulesing, indicating that producers that hold more positive views about listening to consumers were more likely to disapprove mulesing. No relationships were disclosed between the attitudinal components (behavioural beliefs, normative beliefs, and control beliefs) and the perceived risk of flystrike or levels of flock monitoring.

Table 20. Pearson correlations between attitudinal components and approval of mulesing, the perceived risk of flystrike and levels of flock monitoring.

Survey Components		Approval of Mulesing	Perceived risk of flystrike	Levels of flock monitoring
Behavioural beliefs	Pearson	**.723****	.084	.012
The perceived effectiveness of mulesing	Sig.	<0.001	.070	.793
	N	**502**	465	505
Normative beliefs I	Pearson	**.483****	.014	.013
The influence of shearers and other farmers	Sig.	<0.001	.760	.760
	N	**517**	478	521
Normative beliefs II	Pearson	**-.612****	-.051	.006
The influence of consumers	Sig.	<0.001	.263	.895
	N	**525**	487	529
Control beliefs	Pearson	**.653****	.051	.011
The perceived difficulty of phasing out mulesing	Sig.	<0.001	.274	.810
	N	**505**	468	507

Relationships between the attitudinal components and demographic characteristics and the decision to run mulesed-free operations were also examined (Table 21). There were no major relationships disclosed, although, a weak relationship between behavioural beliefs and age was observed, indicating that older respondents tend to hold more positive views about mulesing.

Table 21. Pearson correlation between attitudinal components and demographic characteristics.

Survey Components		Demographics	
		Age	Level of education
Mulesed-free operations	Pearson	.036	-.010
	Sig.	.408	.818
	N	536	535
Behavioural beliefs The perceived effectiveness of mulesing	Pearson	**.089***	-.009
	Sig.	**.046**	.842
	N	**504**	502
Normative beliefs I The influence of shearers and other farmers	Pearson	.032	-.008
	Sig.	.465	.865
	N	520	518
Normative beliefs II The influence of consumers	Pearson	.018	.017
	Sig.	.686	.701
	N	528	526
Control beliefs The perceived ability to phase out mulesing	Pearson	.016	-.035
	Sig.	.723	.428
	N	506	505

In addition to the correlation analyses, a hierarchical regression analysis (using rainfall as first predictor, followed by stepwise inclusion of the attitudinal variables) was conducted to determine which of the independent variables (e.g. attitudinal variables, rainfall) had a statistically significant effect on the decision to run mulesed or mulesed-free operations. A summary of the model for each enterprise type is presented in Table 22. Here, it can be observed that attitudes are important predictors, although they slightly differ according to type of enterprise. For meat producers, behavioural beliefs (the perceived effectiveness of mulesing) are important factors influencing the decision to run mulesed or mulesed-free operations. For meat-wool enterprises, control beliefs (the perceived difficulty of phasing out mulesing) and economic incentives are main drivers. For mixed producers, control beliefs are key factors influencing the decision. For wool growers, behavioural beliefs, control beliefs and rainfall are important drivers for the continuation of mulesing.

Table 22. Summary of the regression model by type of enterprise.

Enterprise type	Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
						R Square Change	F Change	df1	df2	Sig. F Change
Meat-focused enterprise	1	.199[a]	.039	-.017	.96634	.039	.698	1	17	.415
	2	.535[b]	.287	.197	.85846	.247	5.541	1	16	.032
Meat-wool enterprise	1	.103[a]	.011	.005	.78341	.011	2.041	1	191	.155
	2	.540[c]	.292	.285	.66444	.281	75.525	1	190	<0.001
	3	.555[d]	.308	.297	.65859	.016	4.392	1	189	.037
Wool-focused enterprise	1	.222[a]	.049	.035	.93709	.049	3.360	1	65	.071
	2	.684[b]	.468	.452	.70628	.419	50.427	1	64	.000
	3	.713[e]	.509	.485	.68433	.040	5.170	1	63	.026
Mixed production, please specify:	1	.143[a]	.020	.012	.89649	.020	2.293	1	110	.133
	2	.575[c]	.331	.319	.74418	.311	50.637	1	109	<0.001

a. Predictors: (Constant), annual average rainfall (mm)

b. Predictors: (Constant), annual average rainfall (mm), Behavioural beliefs

c. Predictors: (Constant), annual average rainfall (mm), Control beliefs

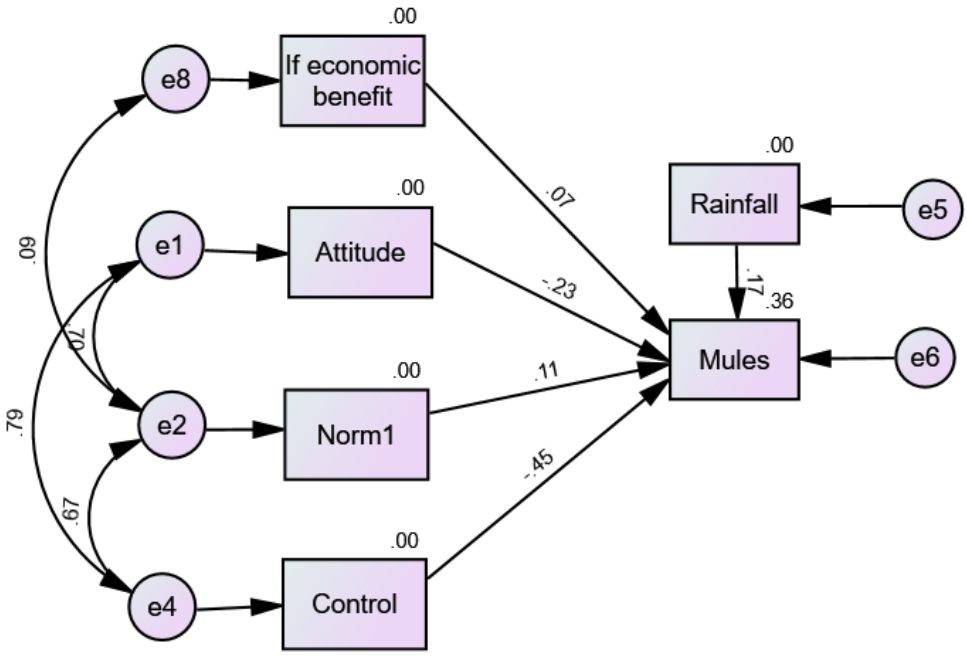
d. Predictors: (Constant), annual average rainfall (mm), Control beliefs, Economic benefits

e. Predictors: (Constant), annual average rainfall (mm), Behavioural beliefs, Control beliefs

The variable 'Economic benefits' refers to score given by the survey respondents to the statement *'I would phase out mulesing if there is an economic benefit'*

Dependent Variable: refers to the outcome (score 1 = mules, score 2= mules sometimes and score 3= don't mules)

Based on the correlation and regression results, a structural model was conducted (Fig. 5) illustrating the relevant factors that influence producers' decisions to run mulesed operations. The model is based on the combined data for all enterprises. Overall, attitudes are important drivers for the continuation of mulesing, with control beliefs (the perceived difficulty of phasing out mulesing) being the most influential factor. Economic incentives and rainfall also influenced the outcome (the decision to run mulesed or mulesed-free operations), but their contribution is smaller than attitudinal factors.



Variables included in the model:

'If economic benefit' refers to score given by the survey respondents to the statement *'I would phase out mulesing if there is an economic benefit'*
'Attitude' refers to the component *Behavioural beliefs* (the perceived effectiveness of mulesing)
'Norm 1' refers to the component *Normative beliefs I* (the influence of shearers and other farmers)
'Control' refers to the component *Control beliefs* (the perceived difficulty to phase out mulesing)
'Rainfall' refers to the reported rainfall in mm
'Mules' refers to the outcome (score 1 = mules, score 2= mules sometimes and score 3= don't mules)

Fig 5. Structural Model