final report

Project code: B.AHE.0313

Prepared by: Richard Shephard
Herd Health Pty Ltd

Date published: 27June 2019

PUBLISHED BY
Meat and Livestock Australia Limited
Locked Bag 1961
NORTH SYDNEY NSW 2059

Piloting an automated endemic disease investigation service for sheep producers

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government to support the research and development detailed in this publication.

This publication is published by Meat & Livestock Australia Limited ABN 39 081 678 364 (MLA). Care is taken to ensure the accuracy of the information contained in this publication. However, MLA cannot accept responsibility for the accuracy or completeness of the information or opinions contained in the publication. You should make your own enquiries before making decisions concerning your interests. Reproduction in whole or in part of this publication is prohibited without prior written consent of MLA.

Executive Summary

Producers are receiving increasing amounts of information on the level of endemic disease within their flocks from sources such as abattoirs. For many producers, this information may encourage them to more actively control disease within their flock. Producers need to understand the optimal control program that they should implement and for most producers and most endemic diseases this is not minimising disease.

The optimal control program is not necessarily the same as the most effective disease control program. An optimal control program reduces disease to the point where the cost of any further reduction will outweigh the extra returns obtained from reducing disease. This can be a difficult concept to grasp. The MLA project (*The Priority List of Endemic Diseases for the Red Meat Industries B.AHE.0010*) estimated the cost of the major endemic diseases of the red meat industry. This included an estimation of the extra realisable profit that could be returned to producers and industry from optimising control. This project adapted the economic framework from B.AHE.0010 into a web-based application that allows a producer to examine the quality and cost-effectiveness of their disease control program.

The Sheep DisCo app is a producer-friendly web-based tool that takes basic information from a producers' flock production and income, summary disease statistics and control activities to estimate the residual losses due to disease that remains in their flock. The cost of control and the residual disease losses can be compared to other producers, to performance in previous years and to explore the effects of proposed changes to disease control. This informs and empowers producers to best manage endemic disease to maximise profit.

The application was built to enable long-term support. The program uses existing .NET architecture that is the mainstay of the MyMLA IT system but operating using a series of links to a domain-expert-maintained spreadsheet for endemic disease economic calculations. This supports extension of the system to other diseases and into cattle in a fast, cost-effective and seamless fashion should Sheep DisCo prove popular with producers.

The challenge for all applications is to be seen and heard above other applications that compete for producer's attention. The positive reception to Sheep DisCo by producer pilot groups encourages uptake and extension. However, a supportive extension plan is recommended to maximise exposure and use. The timing and availability of automated capture of other data sources (e.g. abattoir data) should be considered in any tailored extension program for Sheep DisCo.

Table of Contents

1. Background

Producers are receiving increasing amounts of information on the level of endemic disease within their flocks from sources such as abattoirs. For many producers, this information may encourage them to more actively control disease within their flock. Whilst encouraging greater awareness on endemic disease control is to be supported, it is important that this information does not suggest to producers that they should eradicate these endemic diseases. Most endemic diseases are endemic because they are ubiquitous, and it is either uneconomical or impossible (or both) to eradicate the disease from a flock. Producers need to understand the optimal control program that they should implement.

The optimal control program is not necessarily the same as the most effective disease control program. An optimal control program reduces disease to the point where the cost of any further reduction will outweigh the extra returns obtained from reducing disease. This can be a difficult concept to grasp. A major MLA project (*The Priority List of Endemic Diseases for the Red Meat Industries B.AHE.0010*) estimated the cost of the major endemic diseases of the red meat industry. This included an estimation of the extra realisable profit that could be returned to producers and industry from optimising control.

Producers need a way to explore and to better understand when the addition (or removal) of an extra disease control component (e.g., a vaccination booster) to a control program results in more profit. This profit may come in the form of increased sales (of extra product of higher value), a reduction in disease control expenditure, or both. For many endemic diseases it is possible to over-invest in control such that the marginal addition to control costs more than the extra profit it generates. Simply providing producers information on the level of disease within a flock provides only the residual cost of disease component of the profit equation. Producers needs to know what they would need to spend in order to reduce this residual disease cost.

The development of a user-friendly application that producers and their advisors can use to examine the effectiveness of current and proposed endemic disease control programs is required to inform management. This project developed an endemic disease cost-benefit assessment and benchmarking framework that can be tailored for individual producers' situations as a web application managed by MLA, integrated with all producer data and accessible through the MyMLA portal.

2. Project Objectives

2.1 Project purpose

The project was established to develop and pilot a web-based system which will provide the cost-benefit of improved disease control for up to ten suitable diseases diagnosed at slaughter (CLA, Arthritis (non-specified), Erysipelas Arthritis , Pneumonia/Pleurisy, Liver fluke, OJD, Sheep Measles, Hydatids, Bladder worm, Pimply gut and Grass Seeds). The cost-benefit of control will be estimated by analysing summary flock demographic, production and control data and comparing to high-, medium- and low-disease level spreadsheets developed for the Priority List of Endemic Diseases for the Red Meat Industries (B.AHE.0010). For some producers and some diseases, further control will not be economical. Specific disease-related questions will identify sites of inefficiency (excess

disease and/or cost), uncertainty and provide links to targeted disease control information (e.g. fact sheets).

2.2 Project objectives

The project terms of reference were:

1. Adaptation of the Priority List of Endemic Diseases for the Red Meat Industries (B.AHE.0010) cost-benefit spreadsheets to receive input from users on their flock's NSHMP disease impact and controls. This will allow a standardized comparison of their disease control program to industry-accepted standards.
2. A producer-friendly web-based tool that allows producers to enter their flock details and summary disease statistics in a standardized form to allow the economic impact of disease to be estimated. The tool will be accompanied by an operator's manual describing installation, configuration, use and constraints for the program.
3. The program will ask specific disease related questions to identify control issues for refinement of further diagnostics (through targeted disease investigation lists) and to direct users to relevant information (via hyperlinks to relevant fact sheets and resources) on improving control if inefficiencies are suspected.
4. Success in the project will provide confidence for expansion of the web application to include other endemic sheep diseases not covered in the NSHMP and to beef cattle diseases.

3. Methodology

3.1 Adaptations to the original proposal

The original proposal was for the consultancy team to develop a web application using open-source software. However, discussion with MLA emphasised the importance of consistency between MLA application appearance and operation, the necessity for all apps to be compatible with MLA software architecture (.NET-based system) and the requirement for MLA IT to be able to maintain, adapt, update, integrate and port the application at any time in the future. The development team modified the application development to develop the software system based on a .NET-based architecture that calls and writes data to a .xlsx spreadsheet.

This approach required standardisation of individual disease spreadsheets to a common structure and architecture. This standardisation enabled the application-specific software to call and write information to and from the spreadsheet based on the user input whilst keeping this separate from the problem of maintaining the spreadsheet(as the main calculation repository for the diseases). This separation of web- and application-specific component of the tool from the disease expertise/models that exists in the disease cost-benefit calculator (spreadsheet) has potential to make the combined system easier to maintain, expand and update; the relevant experts have only to maintain that part of the system that they are most familiar with.

The consultancy team provided the MLA software engine in the form of working spreadsheets and the MLA IT team develop the interface around the standardised

spreadsheet. A series of refinements were made, and the working prototype was pilot tested with sheep producers.

3.2 Application description

The application has been nominally called Sheep DisCo. Sheep DisCo is a web-enabled disease input-output system that estimates the residual cost of disease and the expenditure on disease control for a mob or flock based on the inputs of the producer and the disease findings from abattoir and other surveillance. The operator is required to select the disease of interest and then to describe the class of animal and the productivity and commodity pricing profile for the mob. Where this may not be ready to hand, default values are offered to the user. Specific details on the control activities (and their cost) undertaken for the selected disease are entered.

3.3 Application architecture

Sheep DisCo takes input data and enters this into the economic spreadsheet framework that was developed as part of the project *Priority List of Endemic Diseases for the Red Meat Industries* (B.AHE.0010). This spreadsheet was developed by experts in each specific disease and allows calculation of residual disease cost within flock. When this information is combined with the control activities undertaken and the estimated effectiveness and cost of other (currently unused) controls can indicate is more profit can be derived from adaptations to the control program.

The underpinning spreadsheet incorporates complex economic theory with knowledge on disease impacts and their controls to estimate residual disease losses. These workings are not presented to the operator, just the various control costs and the estimate of residual disease within the mob.

Expert opinion has been used to generate the typical range for both input costs and for residual disease cost. Individual performances are presented against the benchmark ranges for both control costs and residual disease costs. This provides individual producer with a comparison of performance of their control program to their peers.

3.4 Workshopping prototype application

A pilot demonstration and discussion was held at Yea on 18 June 2018. Feedback was obtained by producers and recommendations to modify the usability of the program received and modifications implemented. Producers noted that the current disease list was abattoir focused and that there were other diseases that do not cause problems at abattoirs that are of greater interest and importance to them. There are two important message from this: the application architecture supports inclusion of other diseases and the system needs to enable engagement of (external) disease experts in building new disease reports. This endorses the decision to have architecture that combines a spreadsheet repository of disease knowledge (the disease expert) with an integrated, web-enabled database, analysis and reporting application (the IT experts) in semi-independent ways that allows each essential component to work within their area of expertise.

In general, producers commented that this process (and the app) was of value to them. Most producers would use the app to explore their endemic disease control and this previously-

absent feature was regarded as of high value. The ‘what if’ disease management scenario exploration exercise was seen by producers as something best done together with their farm management consultant who could help them with the data entry and assumptions. Full exploration of any individual disease will consume 10-15 minutes, highlights key information required by the producer (or consultant) and explores impact of change in management on residual disease cost, control expenditure and profit. Entry prompts were well regarded as these helped explain to the producer what was known about typical impact of the disease in a flock. It highlights where science was lacking and where a producer needs to focus when considering overall disease impact on farm profit.

Producers mentioned that they are ‘swamped by apps’ and that the drivers to use another app need to be strong. That said, most in the workshop commented that they would use this app if they had a problem to investigate, or if there was a change in prices or circumstances. It would not be regularly used to assess business-as-usual cases. This has implications for benchmarks—the system depends on a representative sample of the population providing data for the comparators to be meaningful. If the system is used only when there are problems, then the underlying benchmarks may be a concern. The system as it was developed, includes mathematically defined distributions of benchmarks developed by the consultants. These may need to persist (and be refined over time) into the final product. The refinement of the benchmarking cloud slider (a graphical representation of the population and with the individual user’s farm position highlighted) will be refined with MLA IT.

Producers also requested more automation—can information from the abattoir be automatically accessed and included into their data entry screens by the app? This led to discussion on the variability within and between abattoirs and a strong desire for more standardised meat inspection and trimming results from the works was expressed. This highlights the industry-wide problem of better integrating data sources. Automatic transfer of enterprise values to all spreadsheets was considered a very necessary improvement to usability. This has for the most part been enabled but some refinement is required. The removal of some input cells may be a pragmatic way to reduce data entry requirements.

Most value may be the ability to use the model to explore options. By being able to explore ‘what if’ scenarios the producers feel they gain a better understanding of the most suitable option for controlling disease in their flock. This has implications for use – we need to ensure that ‘what if’ scenarios are recorded (or not saved at all) and only the actual flock management scenarios are recorded. This will be important for collection and collation of industry-level stats on control practices and residual disease levels.

Some producers were concerned that the program only operated ‘live’ on line. Producers with slow and less reliable internet services suggested the ability for the program to download for local examination may be important. This will be discussed with MLA IT as to feasibility and for options that impact on saving and writing of data to the central database. Producers also want to see the impact of a change directly. This means they want ‘live’ benchmarking. For example, if they choose to add another intervention into their control program, they wanted ability to see the impact on cost of control and residual disease cost immediately. This along with the ability to explore what if scenarios would increase the value

of the application. The ongoing integration of data sources (e.g. LPA, NVD, NLIS through Integrity Systems and via MyMLA) will facilitate inclusion of these addition features.

4. Results

The Sheep DisCo system is described as follows:

4.1 Data input

Inputs are required across three categories:

1. Enterprise and mob details - capture information on the production, value and supply pattern of the mob or flock. These input values once entered for the first time, serve as defaults for other diseases and for subsequent years[1] as they tend to be enterprise specific. See Figure 2
2. Disease details - record specifics about the behaviour of the disease in the mob or flock. This sheet determines the residual cost of disease within a mob after current controls have been applied. See Figure 3
3. Management and control costs - document the activities undertaken, the costs of the activities/treatments/preventives and where relevant, the effectiveness of the control. See Figure 4

The initial entry of data for the first disease is estimated to take 30 minutes for a well-organised producer. Subsequent disease entries will take less than 10 minutes.

Producers may explore scenarios. This allows them to examine the impact of changes to their current disease control program. This important feature helps producers to optimise their disease control programs.

Only actual data from completed years are written to file. Once data is written to file this becomes the default controls and costs for future scenarios. Proposed scenarios are saved only for the purpose of comparison; they are not recorded against a producer. It is important that only actual controls are recorded as this allows the database to be monitored to examine trends in actual disease prevalence, controls and impacts. This valuable feature will allow MLA to target extension into areas that are in most need of improvement and to monitor the uptake and impact of new control technologies as it is rolled out, thereby assisting with estimation of R&D investment benefit-cost performance.

[1] Individual values can be updated

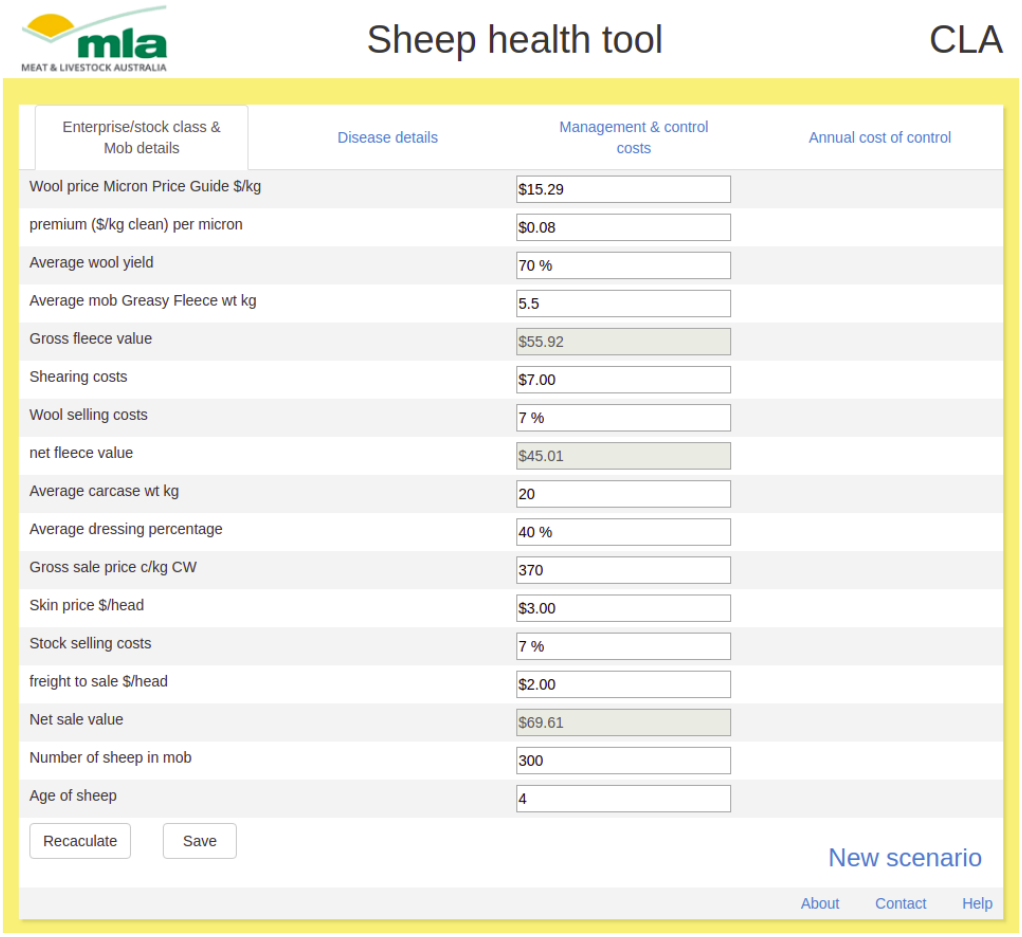

Figure 1: Enterprise class and mob details entry screen for CLA

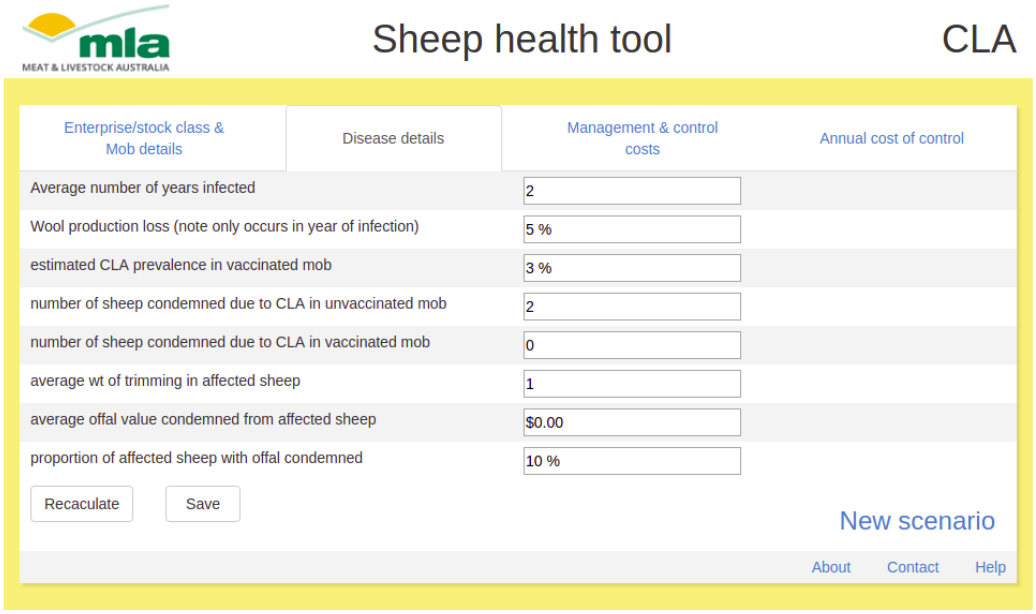

Figure 2:Disease details entry screen for CLA

Figure 3: Disease controls and cost details entry screen for CLA

4.2 Data output

There is a single data output screen per disease. See Figure 4. The residual losses due to disease are itemised against various commodity components of output and for the lifetime production of an animal. The residual cost per mob is estimated and this is presented graphically against the similar estimate for other producers in a benchmarking plot.

Comparison flocks are presented in blue and the current performance of the flock (black) able to be visualised. Various ‘what if’ scenarios involving proposed or considered changes to the control program impacts can also be visualised through different coloured points on the cost and loss slider bars. This feature encourages producers to seek the optimal control for disease within their flocks.

The residual benefit that may be returned to the producer from a change (improvement) to their disease control program is listed. Note that the objective for most producers should be to reduce disease to the level where any residual benefit from extra disease control is less than the cost of implementing that control. This is the point closest to the equimarginal control combination for the disease. Producers that manage each endemic disease such that all controls are implemented that return more profit than the cost of the control are being undertaken - and no more than that - will return the maximum profit. Sheep DisCo encourages producers to optimally control endemic diseases via this approach.

Figure 4: Disease control costs and residual disease losses results page for CLA (with links to information on the disease and its controls)

Hyperlinked information on specific aspects of the disease and its control are provided on the output screen. See Figure 5

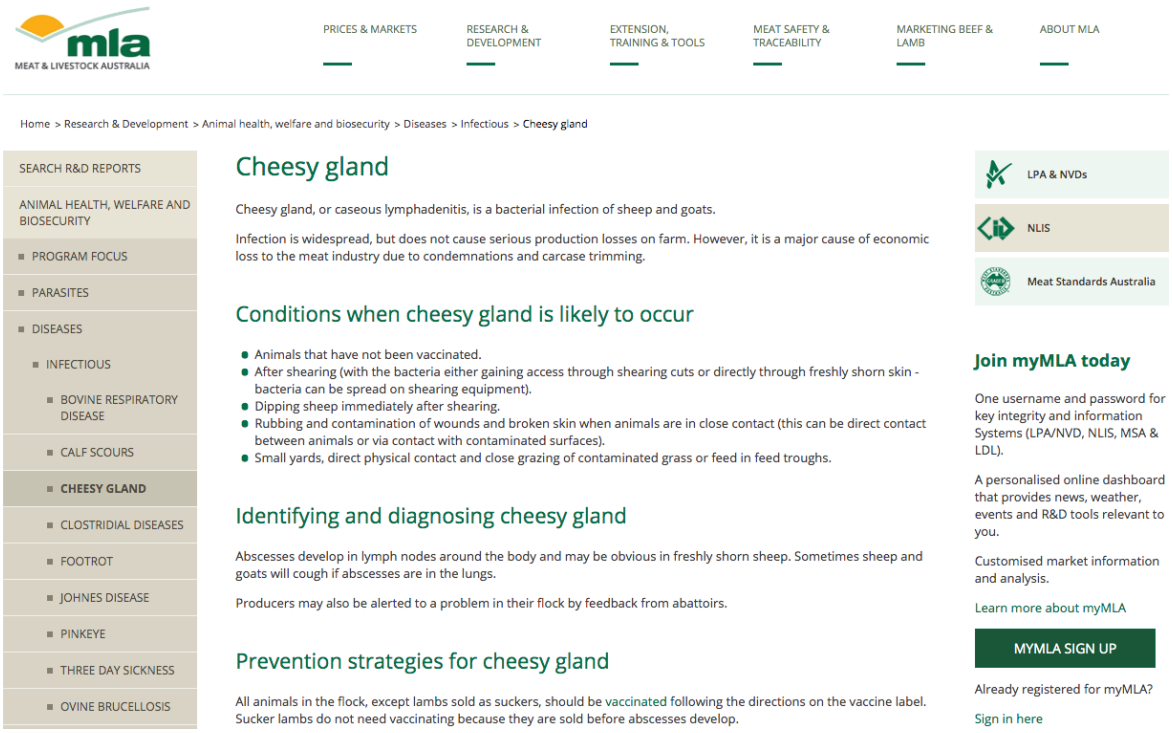

Figure 5: Example of hyperlinked information on a disease and its controls fromSheep DisCo(CLA in this example)

5. Discussion

There is inherent complexity in decision making for managing endemic diseases of flocks in order to optimise farm economic output. Information on the level of disease, the impact on quantity, quality and value of producer, the access to and effectiveness of various disease controls and the cost of the controls and an understanding of economic response curves are needed to identify the best most economic control program for a producer. Calculating this from first principles is beyond most producers - and they have other demands on their time. A system that can draw the required information from producers, estimate the cost-benefit and predicted marginal response and can present the information back to the producer in an intuitive format will encourage producers to move towards optimal disease control.

A simple web-based application that can estimate performance and benchmarking producers against their peers provides this capability. This project developed such a tool. This required a flexible approach to application development. This project demonstrated that the combination of .NET architecture with domain-expert maintained spreadsheets to be an effective way of maintaining operability and future expansion of the system. The disease experts use the tools they are most familiar with to estimate the cost-benefit of disease control. This is a spreadsheet that they can adapt and adjust the spreadsheets. The only requirement is that the architecture of the spreadsheet remains constant; the equations and logic can be changed according. The constant structure of the spreadsheet input and output

cells allows the .NET framework to access and present information. This separation of roles - the domain experts to maintain the disease logic spreadsheet and the MLA IT team to maintain the .NET architecture allows the web based application to be maintained and updated in a seamless manner.

The application was pilot tested with a range of producers. Feedback from producers extended the vision for use of the system. The producers saw value in the ability of the app to explore options for better disease control and to better understand the impact of disease in their flock. This was seen as more of a planning tool for use with the farm management consultant or in a group with a facilitator as opposed to them entering their raw data on every disease each year. Producers were impressed with the program and were keen to see the average cost of control and the residual losses due to disease in their flock and this helped them to better understand if the next control intervention was likely to be economical.

The producers did not see the app as a universally and regularly used tool – at least under the current manual data entry requirements. This may change as more and more data (such as abattoir) data was automatically incorporated (such as through MyMLA). The program has highlighted the abattoir-focus of the disease list (from NSHMP) – producers expressed interest in expanding the list to diseases that have no footprint at the abattoir. This also highlighted the problem of inconsistency in meat inspection (classification of cause) and in trimming/condemnation rates within and between abattoirs. The merit of this (and other) system depends on producers trusting the meat inspection process and this is does not seem to be the case at present.

The application was modified to ensure that producers only recorded actual disease control event data to the database. Various 'what-if' scenarios can be built by producers and their impact on the quality of the control visualised, but these are not written to file - a producer is warned that writing to file will set these values as the default values for future years. The conformance with this requirement will need to be monitored because the data is of great potential value at industry level. Industry may extract value from use of the application by monitoring the disease levels and trends and the controls undertaken by producers on a regional and temporal basis. This can be used by MLA to focus extension efforts, to see the impact of new control technologies and to estimate the residual disease levels and unrealised profit within industry. A well-used tool will assist MLA to evaluate the cost-benefit of R&D investments over time; an important means of assessing performance of any R&D program.

Maintenance requirements will include regular reviews by domain experts to ensure the economic spreadsheets remain up to date and to ensure hyperlinks to information continue to provide the pathway to best knowledge. A similar approach is required for expansion of the system to include new diseases or for expansion into cattle. The spreadsheet disease-based architecture facilitates these enhancements. As more users contribute, the benchmarking data can be updated - either replaced or enhanced through the addition of new data points for reference. A benchmarking system can suffer in early days because of a lack of comparison data. This is they the artificial data was generated by the disease experts as it plays a vital role in encouraging uptake. This may be replaced over time as real data enters the system.

6. Conclusions/Recommendations

The Sheep DisCo system has modified the cost-benefit spreadsheets developed for the *Adaptation of the Priority List of Endemic Diseases for the Red Meat Industries (B.AHE.0010)* project into an application that an individual producer can use to explore and optimise the cost-benefit of endemic disease control in their flock. Sheep DisCo is a producer-friendly web-based tool that takes basic information from producers on their flock production, summary disease statistics and control activities to estimate the residual losses due to disease in their flock. The cost of control and the residual disease losses can be compared to other producers, to performance in previous years and following implementation of proposed changes to disease control. The empowers producers to manage endemic disease to maximise profit and not necessarily to minimise or eradicate disease.

The application has been built to enable long-term support and adaption. The program uses existing .NET architecture that is the mainstay of the MyMLA IT system but operating via links to a domain-expert-maintained spreadsheet for endemic disease economic calculations. This will allow the system to be extended to cattle and to other diseases in a fast, cost-effective and seamless fashion should Sheep DisCo prove popular with producers.

The challenge for all applications is to be seen and heard above other applications that compete for producer's attention. The positive reception to Sheep DisCo by producer pilot groups encourages uptake. A supportive extension plan is recommended to maximise exposure and use

7. Key Messages

There are a number of points arising from this work

1. Optimal endemic disease controls are not obvious to producers. The increased reporting of levels of endemic disease from sources such as abattoirs may increase producer engagement. However, paradoxically, this may also encourage some producers to over control these diseases as they attempt to minimise the level of disease within their flocks.
2. A simple benchmark comparison positioning a producers against their peers and against themselves in previous years for the cost of endemic disease controls and for the residual losses due to remaining disease in their flocks encourages producers to seek good control but not to spend more on extra controls that are likely to cost more to implement than the extra profit they will get back from improved control.
3. A web-based application presents the best way to inform producers and provide benchmarking.
4. The Sheep DisCo application combines domain-expertise knowledge (in the form of *Adaptation of the Priority List of Endemic Diseases for the Red Meat Industries , B.AHE.0100* economic frameworks) with IT requirements (.NET architecture and MyMLA compatible systems) in a robust and sustainable system that can be expanded as required.

5. A considered extension and roll-out program is recommended that is timed to best match other development in producer data centralisation (e.g. LPA, IS, and NVD through MyMLA). The survival of any application depends upon patronage and this is linked to the value that producers see in the information and the ease with which the application provides this information.