Final report

MLA cattle and sheep on-farm model: methods principles

Project code: L.EVA.2001

Prepared by: Will Henderson
RM Consulting Group Pty Ltd

Date published: 28 June 2021

PUBLISHED BY
Meat and Livestock Australia Limited
PO Box 1961
NORTH SYDNEY NSW 2059

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

Executive summary

Background

MLA (Meat and Livestock Australia) undertake a large number of research projects for the benefit of meat producers and the industry. Having a consistent methodology to evaluate the projects both ex post and ex ante is important. MLA have used a "Rendell McGuckian" model in conjunction with other approaches over the last 20 years to assist in this evaluation. The Rendell McGuckian model, whilst useful, had become out of date, inconsistent with MLA's current evaluation approaches and had evolved to become unfriendly to the user.

RMCG, authors of the Rendell McGuckian model, were commissioned to review and revise the model to meet MLA's current needs.

The MLA on farm sheep model estimates the individual farm as well as industry-wide economic benefits of an output (product) from inputs (project investments) funded by Meat and Livestock Australia (MLA). Outputs (products) are broadly defined as any product, practice change or on farm intervention that has attributable adoption (outcomes) and impact (productivity gains or cost reductions). The research will help MLA prioritise expenditure to maximise its benefits to industry.

The main target audience of the research is MLA staff and consultants conducting evaluation of proposed and current products. The estimates produced by the model will be input into MLA's GMIIF model and will inform MLA's project investment prioritisation.

Objectives

The objective of the project was to update and improve the previous version of MLAs on farm model. Specifically to:

- Simplify the model's user interface
- Update the industry and business-level data
- Connect the model to MLA's research evaluation framework
- Split the cattle model into three systems (from two)
- Allow for decay in the adoption of products.

Methodology

The project was developed through:

- Review of the existing model and identifying changes required
- Discussions with MLA regarding the purpose and structure of the on-farm model.
- Gathering up-to-date data on the sheep and cattle industries
- Providing a prototype version of the model for testing within MLA
- Providing an overview and demonstration of the model to MLA staff

Results/key findings

It was found that the fundamental farm production system which the existing model was based was still valid and could be used in the revised model. However there was found to be a need to simplify both the presentation of model workings and the method of inputting data; update the data using

the latest industry ABS census (2016); make changes to the adoption estimates and present the output consistent with use for GMIIF model.

From working with MLA staff and using RMCG knowledge of the industry a model that met the MLA needs was developed.

The resultant model calculates the benefits of MLA programs in the cattle and sheep industries by:

- Determining the change in production and costs at a farm level as a result of the program to calculate the change in farm profit as a result of the program.
- Multiplying this change in farm profit up to industry level, based on what types of farms the program is targeted at and level of adoption predicted

This model breaks the market into segments based upon:

- System, defined by business structure and/or geography.
- Region
- Enterprise (specialist or mixed)
- Business size.

The model has a number of features that improve the accuracy of the estimates produced by:

- Segmenting the industry that guides researchers into thinking about how a product might affect different parts of the industry
- Providing an industry structure that is calibrated to total industry production
- Providing a guide for researchers to estimate adoption
- Providing a robust analytical structure to estimate the impact of an improvements in carrying capacity.

Benefits to industry

The model provides an up-to-date system for evaluating MLA's project investments at the farm level in a simple and consistent way that will provide reliable evaluations. This will give MLA confidence in making decisions about projects. Therefore, the model provides indirect benefits to industry by maximising the industry benefits of MLA's project investments.

Future research and recommendations

The model uses data from the ABS agricultural census (2016), MLA price data and ABAREs farm survey data. The model needs be updated periodically to reflect industry changes. The next update should occur in 2023.

Once MLA has used the model to evaluate a large number of products, it may identify improvements that could be made to future versions.

Table of contents

1. Introduction

1.1 Purpose of the MLA on-farm model

This is used to estimate the farm-gate benefit of improving on-farm productivity.

The improved RMCG evaluation model will be used for the evaluation of products arising from projects that are being considered for funded in the on-farm productivity and producer adoption programs. The model can be used both pre and post project, if used post project, the adoption can be manually entered.

The model aims to be:

- Easy to use
- Transparent
- Credible
- Consistent.

1.2 This update

The MLA on farm model originated from co-funding by MLA and AWI over a decade ago. The model has gone through several stages and alterations. It has gone in and out of use within MLA. The alterations to the model resulted in a model that was complex and difficult to use. The data in the model was out of date.

In addition, MLA has recently developed a new system for evaluating products, and the on-farm model needs to connect with that system. In the past the MLA on farm model has incorporated both the costs and benefits of products. MLA now has a system that compares the costs and benefits of all products. The scope of the MLA model has thus been reduced to calculating only the on-farm benefits of research.

The purpose of this project has been to:

- Simplify the model's user interface
- Update the industry and business-level data
- Connect the model to MLA's research evaluation system
- Split the cattle model into three systems (from two)
- Allow for decay in the adoption of products.

1.3 Model assumptions

The model assumes that:

- The market can absorb at the same price any changes in production.
- Capital for additional livestock and equipment is readily available for profitable products.
- The total area of land in Australia that is utilised for 'meat' production varies depending upon profitability compared with the alternatives (cropping etc.).
- The current land use (as per ABS 2016 data) remains.
- Producers retain all additional profits. In reality These benefits are often short term because shifts in industry supply and demand usually result in the consumer benefitting at the expense of the producer. While the benefits may not result in increased profit it does guarantee the industries future and generates a 'prevention of reduced profit'. We understand that MLA's broader evaluation framework takes this effect into account.
- Each individual product will have negligible impact on supply and demand compared with other factors (e.g. production changes due to overall land use change in response to changes in price). However the model provides estimates of additional meat and wool produced from the existing production system.
- The estimates of impact created by the product are accurate! Predicting outcomes from R&D is difficult. It can be better to identify the most important problem for the industry and then compare products that have the most likelihood of success

Despite these assumptions/limitations it is proposed that the NPV model developed will be useful for evaluating R&D products provided:

- Program managers 'audit' the assumptions and inputs used by product proponents to ensure both consistency, and realistic outcomes; and
- Program managers regularly 'audit' completed products to use as 'benchmarks' for evaluating future products.

1.4 Topics not covered in this document

This document is not a guide to using the model. Instructions and definitions are embedded in the model itself.

2. Model structure

2.1 What the model does

The MLA on farm sheep model estimates the individual farm as well as industry-wide economic benefits of an output (product) from inputs (project investments) funded by Meat and Livestock Australia (MLA). Outputs (products) are broadly defined as any product, practice change or on farm

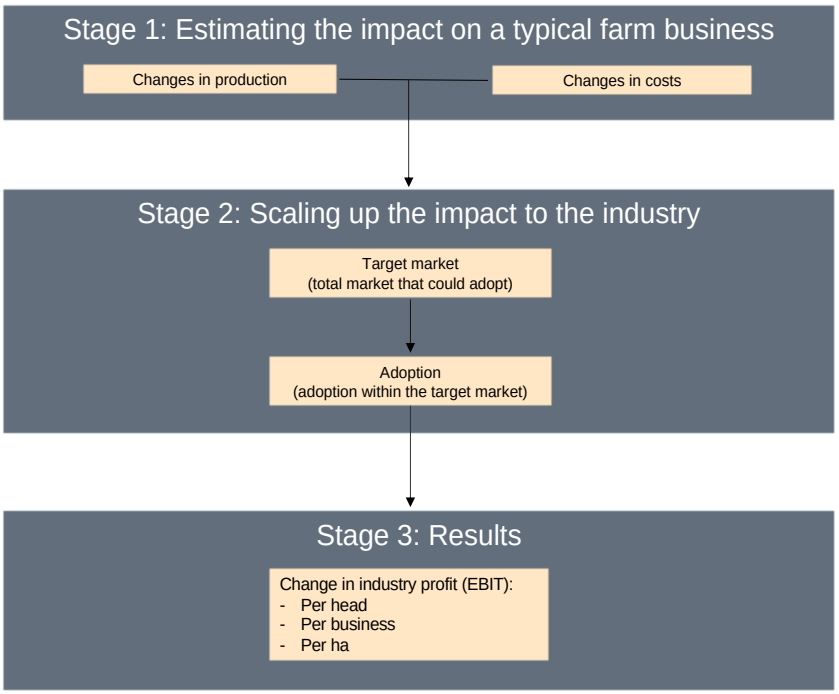
intervention that has attributable adoption (outcomes) and impact (productivity gains or cost reductions). The model does not include MLA's project cost (as was the case with previous versions).

Very simply, the model calculates the benefits of MLA products in the cattle and sheep industries by:

1. Determining the change in production and costs at a farm level as a result of the product
2. Multiplying this benefit up to industry level, based on what types of farms the product is targeted at and level of adoption predicted.

The overall structure of the model is shown in Figure 2-1.

Figure 2-1: Overall structure of the MLA on farm model



2.2 Model Outputs

The model produces estimates of the additional EBIT (earnings before interest and tax) that would be earned on farms across Australia as a result of MLA products. Additional EBIT is expressed per:

- Head (of sheep or cattle)
- Business
- Unit of area farmed (km^2/ ha).

This is to allow products that target adoption across different unit to easily estimate or measure the benefits of the product. For instance, animal health products may target adoption in terms of head, while feedbase products may target adoption in terms of area. The model outputs are intended to be copied directly into MLA's evaluation system.

3. Farm business structure

It is recognised that no two farms are the same (i.e. climate, soils, farm system etc.). However, for simplicity this model assumes a 'typical' farm for each of the systems. These typical farms are used to estimate the impact on profit at a business level of the proposed intervention.

3.1 Cattle farm business structure

The cattle farm business structure is common to each of the three regions. The cattle system is self-replacing in that heifers are retained to replace cows culled for age (cfa). Although many businesses purchase breeding cows and bulls, at an industry level, this does not create additional beef production. If the model were not self-replacing, then it would overestimate the overall industry turnoff when it was scaled up to industry level. The cattle system is shown in Figure 3-1.

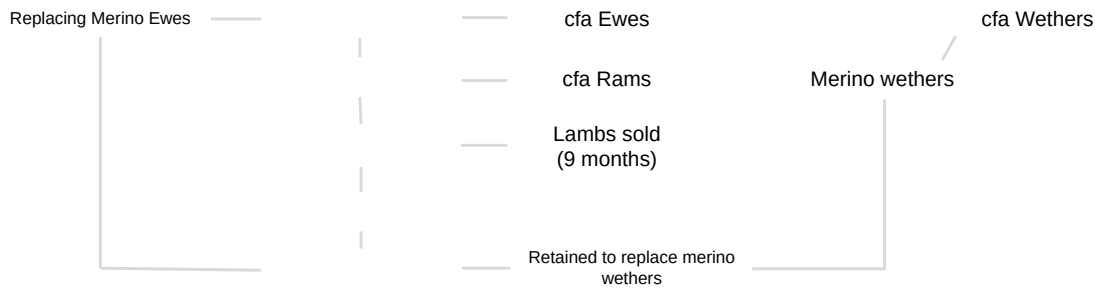
Figure 3-1: Business structure in the cattle systems

3.2 Sheep

Within the sheep model, there are basically two types of business structures: one structure for merino, dual purpose and pastoral systems, and another structure for the meat sire system. Both systems are self-replacing. In practice some business produce young wethers for sale and others only trade in wethers. The same can be said for first cross ewes and lamb producers. As with the cattle model, so that the results can be scaled to industry level, this model does not split out the production systems for breeding and fattening enterprises. The structure for the merino, dual purpose and pastoral systems is shown in

Figure 3-2.

Figure 3-2: Business structure for the merino, dual purpose and pastoral sheep systems



The structure for the meat sire is shown at Figure 3-3.

Figure 3-3: Business structure for the meat sire sheep system

4. Segmentation

4.1 Overview

Businesses react differently to information according to their size, demographic and type of business. Certain products will only be and adopted by farmers in a particular region, size of business or farming system. By segmenting the model, it is easier to estimate the realistic adoption of a particular product.

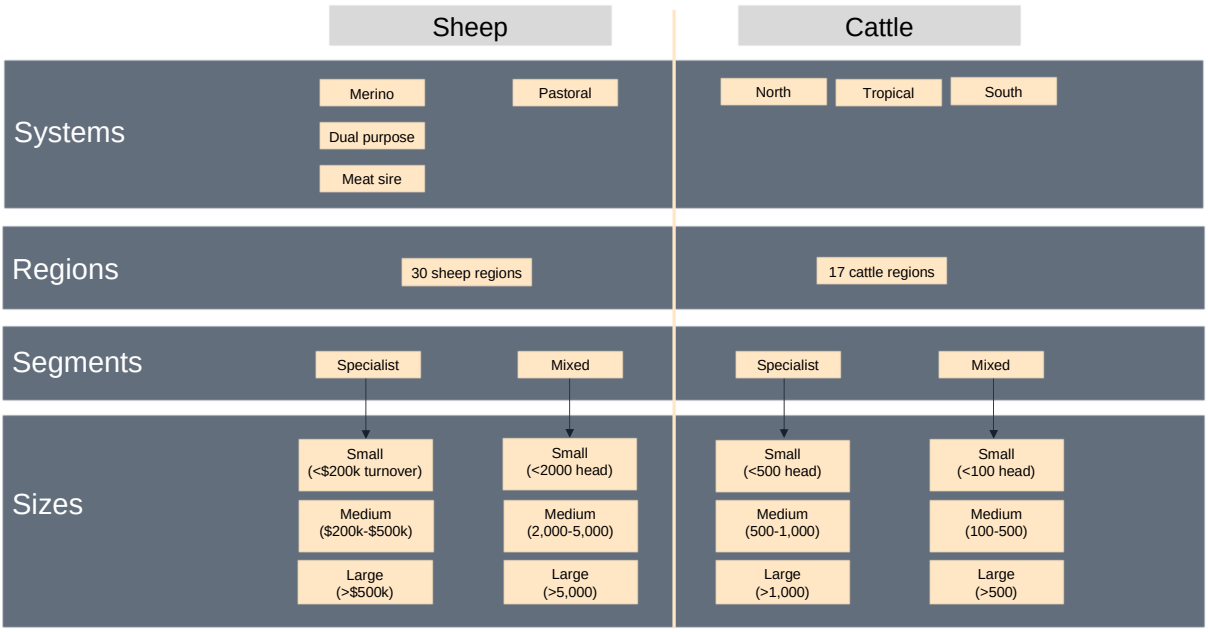
This model breaks the market into segments based upon:

- System, defined by business structure and/or geography.
- Region
- Enterprise (specialist or mixed)
- Business size.

The basis for the market segments is analysis carried out by RMCG, MLA and agricultural data company Kynetec.

An overview of the structure of each model is shown in Figure 4-1.

Figure 4-1: segmentation within the MLA on farm model

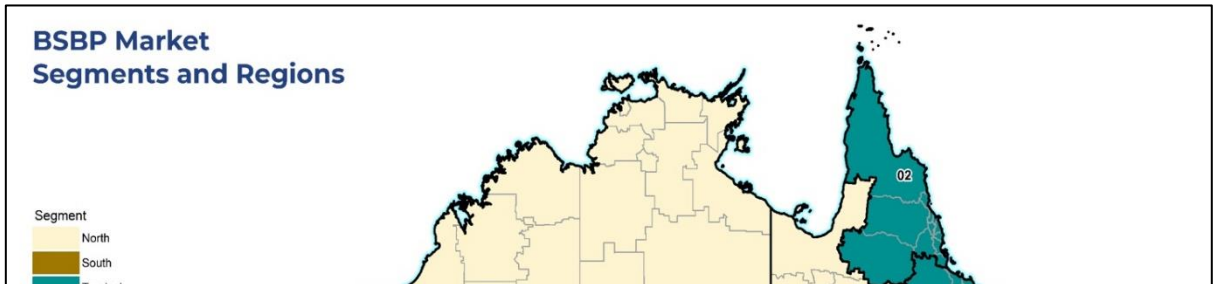


4.2. Systems

Cattle

The cattle model is divided into three segments: north, south and tropical.

Figure 4-2: Cattle regions



Sheep

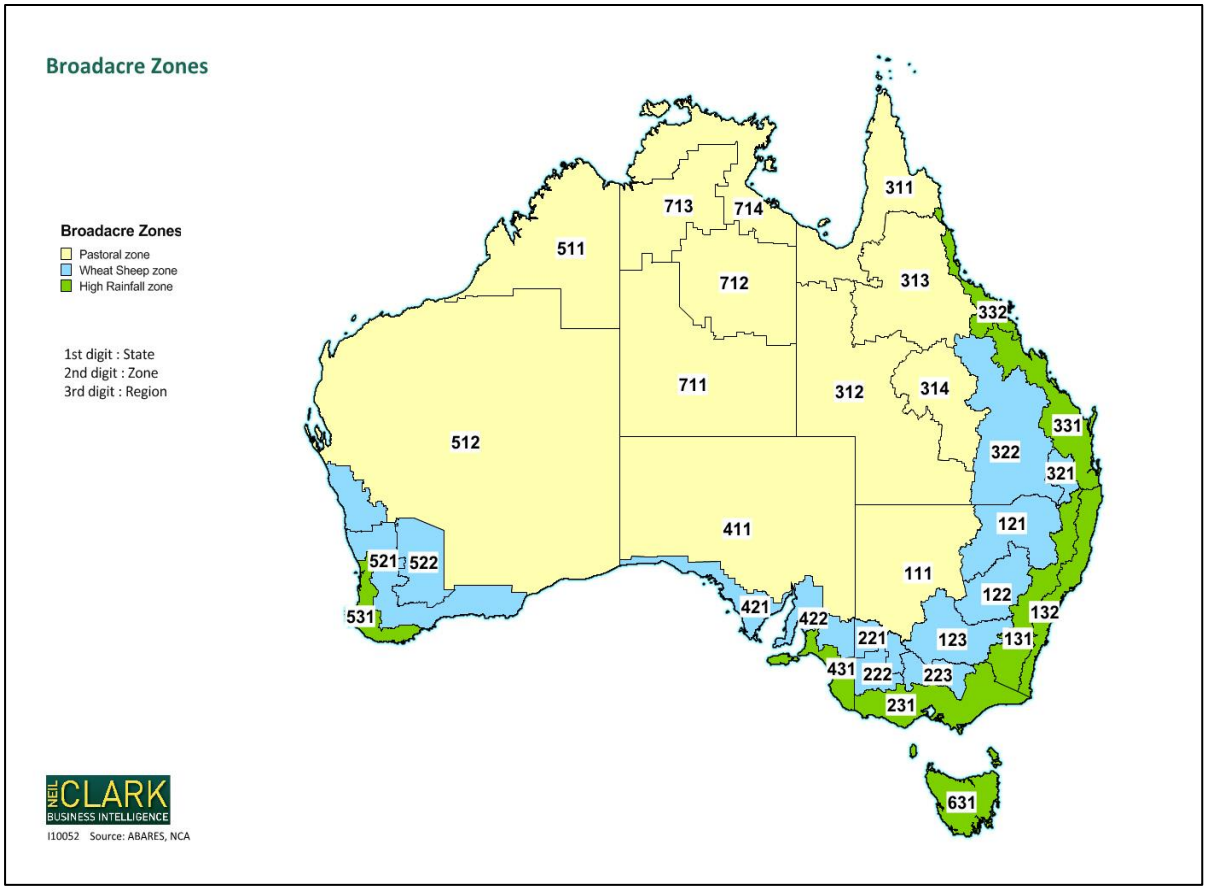
The model divides the sheep industry into four systems that are based on geography and whether the business is focussed on producing wool or meat. The merino, dual purpose and meat sire systems are all in the same zone: wheat-sheep and high rainfall, while the pastoral system encompasses all sheep producers in the pastoral zone. The characteristics of the four systems are shown in Table 5 1.

Table 4-1: sheep systems

SYSTEM	ZONE	WOOL QUALITY	MEAT QUALITY	ABS CLASSIFACTION
Merino	Wheat-sheep and high rainfall	High	Low	Less than 10% of ewes mated to meat breed rams
Dual purpose	Wheat-sheep and high rainfall	Medium	Medium	More than 10% and less than 90% of ewes mated to meat breed rams
Meat sire	Wheat-sheep and high rainfall	Very low	High	More than 90% of ewes mated to meat breed rams
Pastoral	Pastoral	Low	Low	All farms in the pastoral zone

The geography used to distinguish the systems is shown in Figure 4-3.

Figure 4-3: geography used for the sheep model (merino, dual purpose and meat sire systems are located in the wheat sheep and high rainfall zones, pastoral system located in the pastoral zone)



5. Farm business data

5.1 Prices

Prices included in the model are:

- Liveweight prices for various classes of animal, varying by system
- Wool prices

The prices drive the modelled estimates of revenue per head, per business and across the entire industry.

Prices were derived from MLA's Statistics Database at http://statistics.mla.com.au/Report/List.

- A three-year average was used (2018 to 2020) so that the prices reflected a somewhat long-term price, rather than a spike in the market.
- For cattle prices, the price differential between states was investigated and no systematic differential was found. Therefore, the same set of prices was used for all regions.

5.2 Production

Production data is input data that determines the quantity of meat and wool produced on the typical farms. This data includes:

- Birth rates
- Mortality rates
- Livestock growth rates
- DSE per head
- Wool production per head.

This data was sourced from the ABARES Farm Survey (https://apps.agriculture.gov.au/mla/).

A 10-year average was used to smooth out climate-related fluctuations.

This data is available at regional level (33 regions across Australia). These regions were matched as best as possible to the boundaries used in the model. The data is a sample of farms in each region. A weighted average was used to aggregate the regions to the larger zones used in the model.

5.3 Costs

The source and method for the business cost data was the same as for production data.

The only difference is that costs were scaled to the income of each of the typical businesses. Within the ABARES farm data each cost was calculated as a percentage of income. This percentage was then applied to the income generated by the each of the typical farms.

The ABAREs cost categories were aggregated in the model as shown in

Table 5-1.

Table 5-1: aggregation of ABARES cost categories to the MLA on-farm model

ON FARM MODEL COST CATEGORY	ABARES COST CATEGORY
Crop and pasture chemicals	Crop and pasture chemicals
Depreciation	Depreciation
Fertiliser	Fertiliser
Fodder	Fodder
Freight	Freight
Fuel, oil and lubricants	Fuel, oil and lubricants
Handling and marketing expenses	Handling and marketing expenses
Livestock materials (drenches, dips etc)	Livestock materials (drenches, dips etc)
Owner allowance $/business	Imputed labour cost
Repairs and maintenance	Repairs and maintenance
Seed	Seed
Wages paid to hired labour	Wages paid to hired labour
	Payments to sharefarmers
Other costs (beef), shearing and crutching (sheep)	Shearing and crutching
Other costs	Administration expenses
	Total rates (incl water)
	Contracts
	Agistment
	Other cash costs
Not included in model	Leasing payments
	Interest payments
	Land rent

6. Industry data

6.1 Data Source

Data on no of head and businesses was sourced from the 2016 ABS Agricultural Census, which collected data on the 2015/16 financial year. The census is conducted every five years, with the next census due to collect data about the 2020/21 financial year. Data from the census will be released in stages, starting in mid-2022.

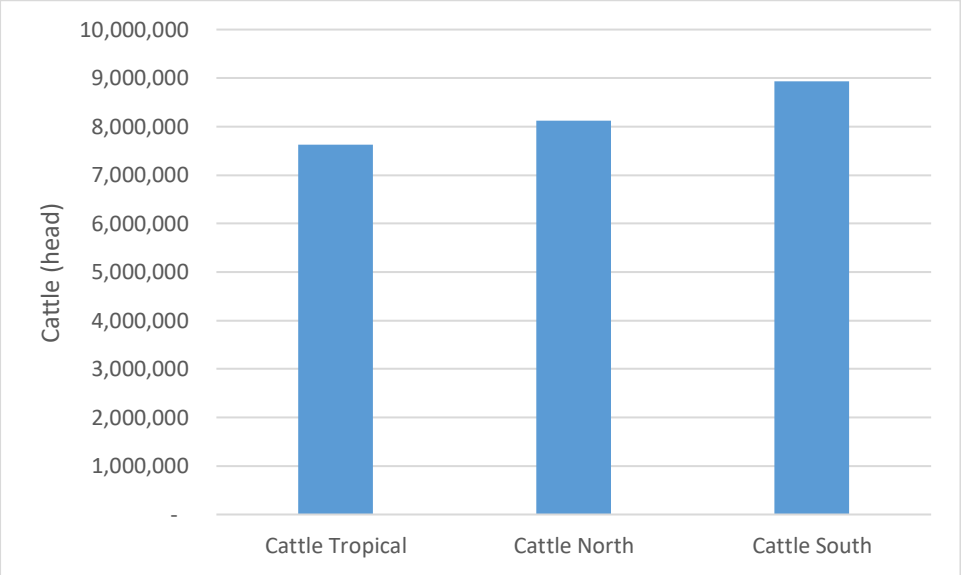
6.2 Business size and production

This section provides a brief overview of each industry according to the ABS data on businesses and livestock. It provides clues for MLA as to where the majority of production is located, and therefore where interventions should be targeted to achieve the biggest return.

Cattle

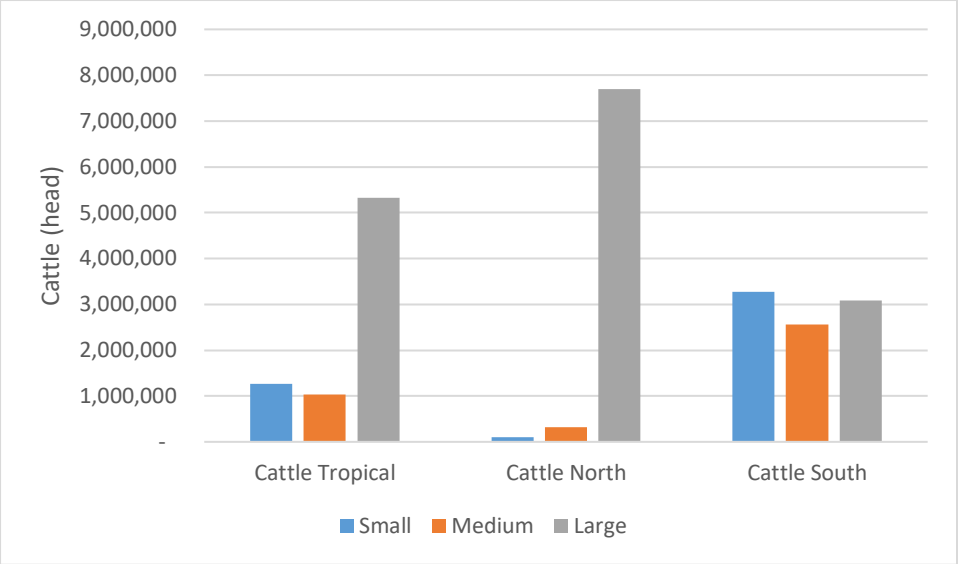
Each of the three cattle regions have roughly one third of national production.

Figure 6-1: Number of cattle by region



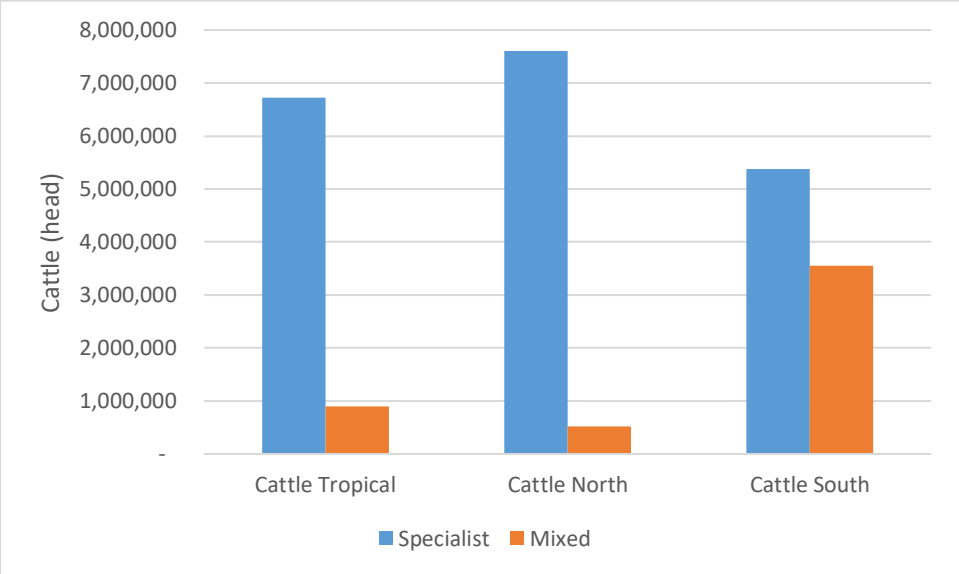
Within each region there are clear differences on the number of cattle by business size. In the north and tropical regions, the vast majority of cattle are produced by 'large' businesses. In the south, small and medium businesses account for a significant proportion of production in that region, just by virtue of the large number of those businesses.

Figure 6-2: Number of cattle by business size



Most of the production is within specialist beef businesses, particularly in the tropical and north regions.

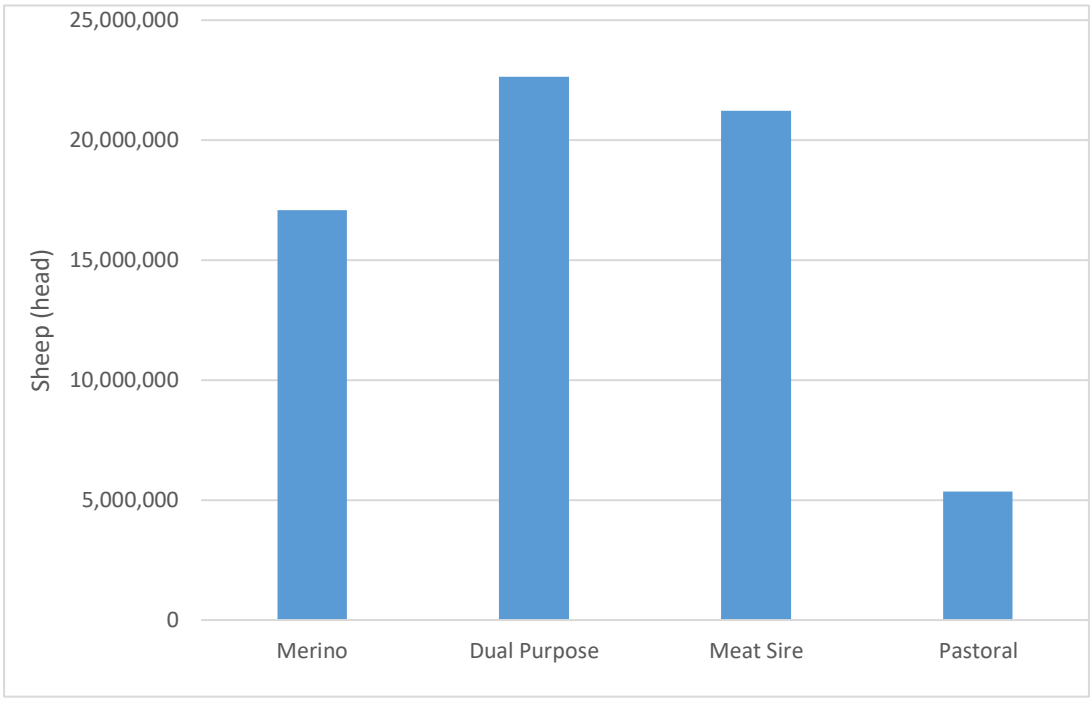
Figure 6-3: Number of cattle by specialist/mixed



Sheep

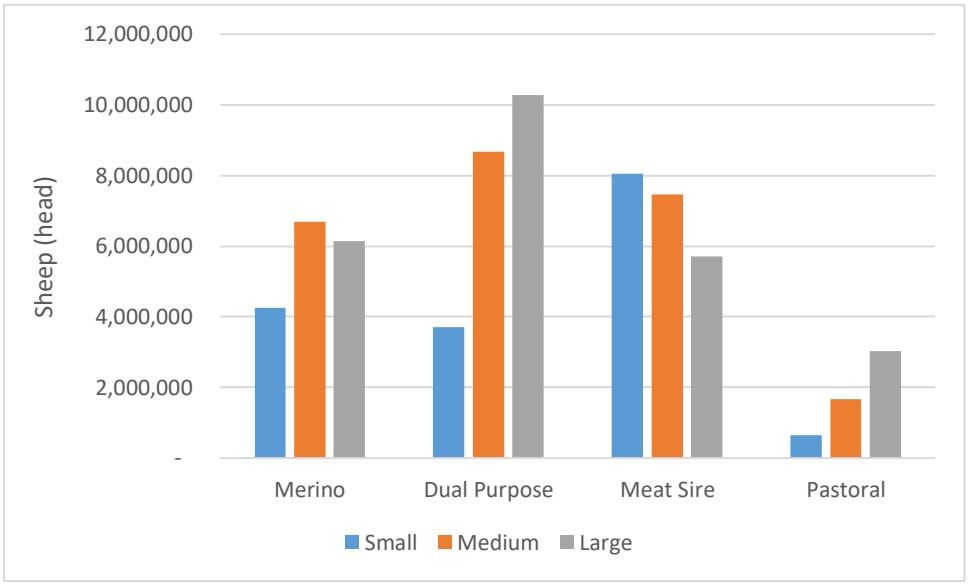
The number of sheep in each system is shown in Figure 6 4. This shows that the pastoral system is relatively small, compared with the production in the high rainfall and wheat zones.

Figure 6-4: number of sheep by system



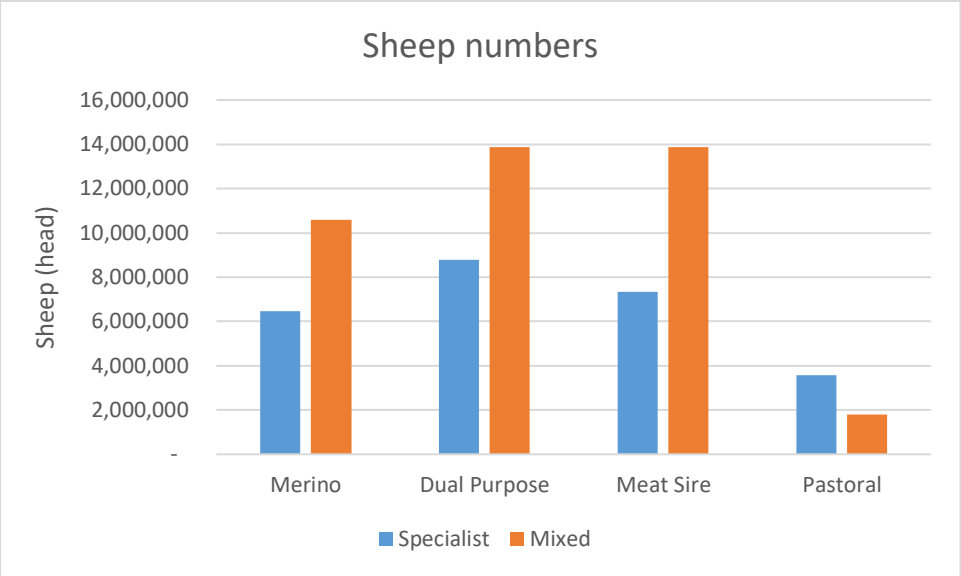
As with cattle a relatively small number of large businesses (9% of businesses) account for a high proportion of production (38% of production).

Figure 6-5: Sheep numbers by business size



60% of sheep are in mixed businesses (Figure 6-6).

Figure 6-6: Sheep numbers by farm type (specialist/mixed)



7. Stocking rate calibration

This calibration will be used when a product results in an on-farm change in the carrying capacity (an increase in the potential number of livestock carried) and/or the animal mix.

A change in carrying capacity can be the result of a product that results in an increase in the amount of pasture or home-grown feed, with no other production benefits. Feed conversion efficiency (FCE) is a measure of the amount of liveweight produced for kilograms of feed fed. In a livestock system, an improvement in the feed conversion efficiency can be achieved by either improved genetics of the livestock or the quality of home grown feed. This improvement is seen in the meat sire farming system.

A change in animal mix through a change to the mortality rate, birth rate, ratio of wethers to ewes or dse/head. Without an increase in the carrying capacity, the number of ewes carried on the property will decrease to account for the extra numbers in another age group.

A product may result in both an increase in the carrying capacity and a change in animal mix.

The model calibrates automatically with the press of a button.

8. Model validation

8.1 Summary of the validation process

The model scales business-level impacts up to industry level. In doing so, it produces estimates of production at national level in terms of head slaughtered, tonnes and value produced. The model estimates are compared with actual figures.

The accuracy of the model estimates is determined by the accuracy of the input data. The model uses the following input data:

- Average production characteristics at the business level, such as mortality rates, birth rates, animal growth rates. Of the input data, this data is likely to have the highest error margin, as it is sourced from a sample of businesses.
- Number of head and businesses across the industry. This data is likely to be reliable as it is from the ABS Census.
- Prices (livestock and wool prices). This data is sourced from saleyard data.

From this data, the model estimates total production across the industry in terms of:

- Number of head slaughtered
- Tonnes of liveweight produced
- Wool produced
- Value of production

The model estimates are compared against actual data for these three items. The model estimates will not exactly match actual data. However, they should be in the same ballpark. Given that the model is used to compare the relative benefits of products, a small error in the model estimates should not be a problem.

8.2 Issues with the validation

Some issues that should be considered when comparing model estimates with actual data:

- The model includes any turnoffs from an Australian extensive farm, no matter where that animal goes. Therefore, live exports need to be included in the actual data.
- Similarly with the above, some animals (particularly cattle) are sold to feedlots for further weight gain. The actual (i.e. not modelled) data does not distinguish between production on extensive farms, versus feedlot production. This will mean the model estimates for tonnes and value (but not head slaughtered) are lower than the actual (unless feedlot production is factored in).
- Slaughtered cattle include dairy cattle, making the actual production figures higher than the model estimate.
- Prices used are 3-year averages, whereas the comparison value is at one point in time, potentially accounting for differences in value of production.