The value of live sheep exports from Western Australia

A review of adjustments that would be required if live sheep exports from WA ceased

Prepared for RSPCA Australia

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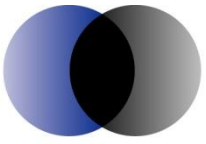

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Executive summary

Approximately 4.2 million sheep were exported from Australia in 2008. On average, 75-80% of live sheep are exported from Western Australia to the Middle East where they are slaughtered according to religious custom.

In late 2008, RSPCA Australia commissioned a study to look at the likely scale and scope of the adjustments that would be required to the WA sheep industry if the exportation of live sheep were to cease. This study was undertaken at a time of continuing structural adjustment in the Australian sheep industry. Due to ongoing dry conditions, depressed wool prices and relatively strong crop returns, the Australian sheep flock has contracted to levels of the early 1930s.

The live sheep trade has developed in Australia because the economic returns from this activity exceed the costs. For those involved in the trade, there are strong incentives to improve the health and mortality rates of sheep in transit. However, the incentive to manage the health of the animal only extends to the point where the costs are lower than the economic benefits internal to the trade; this decision may not fully take into account all of the animal welfare concerns of the wider community.

This study has employed an unconventional, yet very comprehensive, method for valuing the live export trade for sheep enterprise managers in WA by analysing the whole of flock changes that would result from a cessation of the live export trade.

Each sheep enterprise manager in WA makes management decisions that include the option to sell sheep to the live export trade provided that the sheep meet certain health, age, weight and condition score specifications. That is, the live export trade is one marketing option for the sheep enterprise that may or may not be used. Removing this option will affect the breeding, genetic selection, pasture management decisions for the whole flock.

The adjustment process in the event of a cessation of the trade was modelled for three different flock structures typically run in WA:

- A merino flock where a proportion of the wethers are retained for wool production for 5 years.
- A merino flock where all wethers are sold before they reach 2-3 years old.
- A merino ewe flock where a mix of merino and first-cross lambs are produced.

This analysis has identified that while adjustments would be required by WA sheep producers; they do not appear to be extensive compared to other structural adjustments already underway in the industry:

- Sheep suitable for the live export trade are only one of a wide range of outputs of a merino flock on an average WA farm with live sheep equating to 3-7% of total farm receipts for farms with more than 300 sheep.
- The adjustment costs are about 3- 7%of the investment value of a ewe or wether, where increasing merino and cross bred prime lamb production is possible.
- Where switching to selling merino wethers earlier for slaughter or switching to prime lamb production is not available, the cost could be as high as 13% of the value of a wether. However, this is likely to be a small proportion of the total farming population in WA.
- For mixed farming systems, which account for the majority of WA farm businesses, the loss of the option to sell live export sheep is not likely to create a significant incentive to replace large areas of pasture with crop because other drivers of land use change are already providing this incentive, e.g. below average rainfall, declining wool prices, and higher productivity gains in cropping.

The cost of adjustment to a market where the live sheep trade is not available could be minimised by progressively phasing-out of live sheep exports. This would allow flock structures to be altered and wethers suitable for the live export trade to be gradually sold off. By phasing out the live sheep trade over a period of five years, the impact on the Australian economy would be $200 million.

A system could be established whereby WA sheep farmers are allocated an annual quota of sheep able to be supplied to the live export market. To allocate these quotas efficiently, there are three options:

- auction off the quota allocations at the beginning of each year;
- issue to each producer a share of the quota, pro-rated on the number of sheep they have as a proportion of the total state flock; or
- issue the quota pro-rated on the historical number of sheep as a proportion of the total number of sheep sold to the live export market by each farmer, averaged over the last 4 or 5 years.

Quotas would be freely transferable allowing farmers to sell their quota, or a portion of it, to other farmers. This would allow those farmers most affected by the cessation of the trade to defer the majority of the costs of adjustment for as long as possible or allow farmers to use some of the efficiency gains of the quota system to offset some of the adjustment costs.

This analysis has identified that, for an average WA mixed farming enterprise:

- Adjustments would be required by WA sheep producers, but they do not appear to be extensive compared to other structural adjustments already underway in the industry.

- The option to sell sheep to the live export trade is likely to worth a one off adjust in the value of a wether of somewhere between $2.00 and $6.00 depending on the alternative flock structure options a farm has. For ewe dominant flocks the adjustment in the value of the ewe would be closer to $2.00.
- If the government decided to intervene and cease the trade, a transferable quota system would allow farmers to defer or offset some of their adjustment costs.

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1 Introduction

ACIL Tasman was asked by the RSPCA to review the likely scale and scope of the adjustments that would be required by the WA sheep industry if the export of live sheep were to cease. It is relevant to concentrate on the WA live sheep industry for two key reasons. Firstly, the majority of animals (by number) exported live are sheep, and the vast majority of these sheep come from WA.

This information presents the opportunity cost of stopping the live sheep trade, and the scale of any adjustment assistance might be offered to make growers indifferent to the continuation or cessation of the trade.

An analysis of the types of adjustment that would be needed if the trade were to cease (even if only temporarily), is important for those opposed to the trade and growers alike. This market is volatile and dependent on the policies of foreign Governments; for Western Australian farmers, information on the adjustment process should the market cease, is valuable.

ACIL Tasman has no view on the live trade other than to ensure that the Australian community makes an informed decision and growers are well prepared if the trade is curtailed or ceases.

2 The nature of the problem

All economic activity produces costs and benefits, some of which are borne by those who are party to the transaction and some borne by others. The costs and benefits borne by those not party to the transaction are called 'spillovers' or 'externalities', as they are external to the activity; consequently there are no prices attached to them.

In most instances there are limited incentives for negative externalities to be managed or reduced by those involved in the transaction, as they are not affected by them unless they can be held accountable for any economic damage caused. For instance, spray drift is a negative externality where it causes damage to crops or horticultural production, but there are strong incentives for farmers to reduce its effects as they could be sued by neighbours. However, where there is no economic damage, such as a case of reduced social amenity, there is no recourse via the courts unless laws are breached.

Externalities can also be positive. Improved fuel efficiency in cars can reduce running costs and improve air quality. Reducing spray drift not only reduces the liability a farmer may face but also reduces the amount of pesticides entering the ecosystem.

The costs and benefits of an economic activity are much broader than the financial costs. In the case of the live trade in animals, social concern for the welfare of the animals is of concern to most people and is an externality of the trade.

For those involved in the trade, there are strong incentives to improve the health and mortality rates of sheep in transit. At the end of long voyage, a healthy live animal is more valuable than a sick or dead one. However, the incentive to manage the health of the animal only extends to the point where the costs are lower than the economic benefits internal to the trade; this decision does not fully take into account the animal welfare concerns of the wider population.

When live sheep producers and exporters are not confronted with the full costs of production (inclusive of the animal welfare concerns of the wider community) they may be making a suboptimal investment decision.

However, cessation of the live export trade would be costly to those currently engaged in it. This is the reciprocal nature of the problem: continuation of the trade causes concern for the welfare of the animals, while ceasing it reduces the contribution the livestock industry makes to the economy and to the businesses involved.

> The nature of the choice is clear: meat or crops. What answer should be given is, of course, not clear unless we know the value of what is obtained as well as the value of what is sacrificed to obtain it (Coase, 1960).

This paper considers:

- what adjustment costs would be incurred by producers of animals suitable for live export if the trade were to cease; and
- how the impact of a cessation of the trade could be reduced, either in response to a halt to the trade due to factors external to Australia, or the banning of the trade by an Australian government.

The net welfare effects of a cessation of the exportation of live sheep from Western Australia is not considered in this report.

3 Our approach

ACIL Tasman's approach to this analysis has been undertaken in two broad steps. The first is to gain an understanding of the economic value of access to the live export market and hence the cost of ceasing the trade. As part of this step, ACIL Tasman has also analysed the adjustments that would be required to a range of farming systems currently selling sheep into the live export market.

The second step in this analysis is to review how the costs of the cessation of the trade could be reduced.

Exporting live sheep provides Australian sheep producers, and in particular Western Australian sheep producers, a selling option for their stock. Not all sheep producers produce sheep suitable for the live export trade each year. Most do not sell any, or only sell a very small proportion of their surplus stock, to live exporters (Drum and Gunning-Trant 2008).

However, at present each sheep producer in Western Australian has the option, but not the obligation, to sell stock into the live export market. Having this option affects the investment decisions farmers and others make, on properties that have the physical capacity to produce sheep suitable for live export sheep markets.

The value of the option to sell sheep into the live export market increases as the number of alternative options falls. The value of this option is also affected by:

- The risk of the market not being available due to political intervention in importing countries
- The cost of switching resources used to produce live sheep to alternative uses (inclusive of physical constraints on the capacity to change enterprises)
- The price of live sheep compared to other classes of sheep.

To assess the value of the option to deliver sheep to the export trade, ACIL Tasman has employed real options methodology. Real options is a method based on the valuation techniques of financial market options but applied to real events and opportunities. In essence, real options compares sheep production enterprises with the option of producing live export sheep, with those that do not. Real options methodology does not assume that live export sheep will be produced by the enterprise being analysed. Rather, it compares the value of a series of investment decisions and outcomes, with and without access to the live export market.

The second part of this analysis examines the policy instruments that may be used to reduce the impact of a cessation of the live sheep trade. This section reviews the effects of a phasing in of the banning of live sheep trading and how this process could be made to achieve the most efficient use of resources during the phase out period.

4 What are live sheep exports?

Live sheep exports, for the purpose of this report, refers to the transport of live sheep from Australian farms to overseas markets, where they are slaughtered for their meat and hides. Live sheep exports can be characterised

as large volume shipments of animals that can be processed and consumed within a short time after reaching the destination country. Typically, they are of an age and condition that yields reasonable quality meat, provided that the animal at least maintains live weight and condition score during shipment.

Sheep exported live are generally castrated merino males (wethers). The most frequently shipped sheep are 50 – 60 kg live weight (LWT) wethers up to full mouth (up to and including 4 years old).

Animals to be exported must meet a standard of condition score and health status set out in the Australian Standards for the Export of Livestock. Additional guidelines have also been established by the industry and can be found in *Is it fit to export?* (MLA, Livecorp, Department of Agriculture Fisheries and Forestry 2007). These standards set out a comprehensive list of health and welfare conditions that are required to be met under Australian laws. Of interest in this report are the condition scores, age, sex and reproductive status. In summary, the Australian standards of interest for this report are:

- Ewes over 40 kg must be pregnancy tested by ultrasound within 30 days of export
- Lambs must have been weaned for at least 14 days
- Lambs must be in excess of 28 kg
- Wool length must not exceed 25 mm
- Export sheep must be more than 10 days off shears (or accommodated on sheds on the registered premises)
- When destined for human consumption, the animals must comply with all Australian food safety requirements, including standards for chemical residues or environmental contaminants.
- Export sheep must not be emaciated or over-fat (must be within condition score 2 to 4 (inclusive) on a condition score scale of 1 to 5.

The cost of meeting the requirement to pregnancy- test ewes within 30 days of export, usually makes exporting live ewes prohibitively expensive. Ewes also generally have a higher value when used for breeding, particularly as prime lamb prices have risen over recent years.

Some speciality breeds are exported live, such as Damara fattail and ram lambs. Statistics on the exact age, weight and condition score of sheep exported live are not readily publicly available. Summary examples of the live sheep export specifications are listed in Table 1 by Elders, the largest exporter of live stock from Australia (Elders 2008).

Table 1 **Some examples of the live export markets serviced by Elders**

Country/Region	Weight	Breed	Age	Sex
Middle East	50 – 60 kg	Wethers	Up to full mouth	Castrated males
	34 – 37 kg	Merino lambs	Lambs	Castrated males
	34 – 37 kg	XB lambs	Lambs	Castrated males
	55 – 65 kg	Rams	Up to full mouth	Males
	36 – 40 kg	Damara F1 ram lambs	Lambs	Males
Saudi Arabia	36 – 38 kg	Any ram lamb with tail	Lambs tooth	Males
	42 – 45 kg	Ram hoggetts /with tail	Max 2 tooth	Males
	48 – 50 kg	Rams	Up to 4 tooth	Males
	35 – 40 kg	Damara fattail	Up to 4 tooth	Males
	50 - 60 kg	Wethers	Up to 6 tooth	Castrated males
	Note: Health protocol requires Scabby Mouth vaccination program to Saudi Arabia.			
Kuwait	52 – 62 kg	Wethers	Up to full mouth	Castrated males
	44 – 50 kg	Young wethers	2,4,6 tooth	Castrated males
Jordan	45 – 52 kg	Wethers	Up to 4 tooth	Castrated males
Egypt	50 - 55 kg	Merino wethers	Lambs - Up to 4 tooth	Castrated males

Data source: (Elders 2008)

The standards and range of sheep required by the markets make the live sheep trade flexible in the livestock specifications it can handle, provided the sheep are healthy and meet export condition standards (MLA, Livecorp, Department of Agriculture Fisheries and Forestry 2007). This flexibility has value for farmers when making production system decisions that may produce sheep that fit the live export standards.

5 What are the key drivers of change for farms?

Drivers that affect land and other resource use changes are those that confer an improvement in the marginal rate of return per unit of inputs, relative to other possible uses and, in particular, relative to current use. The marginal rate of return will usually be assessed against the availability of the input that produces the largest constraint on the business. The most common inputs that constrain the expansion of an enterprise are land (except in pastoral zones), irrigation water and labour. In the areas of interest for this study, the land is likely to be the input that imposes the greatest constraint, and returns per ha are likely to be a key determinant in enterprise selection at the margin.

Labour has been a key input constraint in Western Australia due to the mining boom. Recent world financial market conditions may see some labour freed up for other sectors of the economy, although Western Australia's unemployment rate is not likely to jump significantly. Labour availability has been cited as a

major constraint on the expansion of the state's meat processing sector (Clarke, Yates and Morison 2007).

Clearly this raises an enormous range of factors that can, and do, influence land and resource use decisions, of which access to the live export market is just one. Factors affecting land use decisions at the margin must also take into account scale and scope economies. For example, the decision to change land use from grazing to cropping may require the purchase of tractors, trucks and tillage equipment. To be viable the cropping enterprise must be of sufficient scale to justify the machinery investment. Thus land use change is likely to be experienced in step changes, rather than continuous marginal changes – and assessment of the risks and capital resources associated with such step changes is a factor influencing whether, and when, land use changes are made, even when financial modelling suggests a change is worthwhile.

While the concept of the effect of scale economies on land use change is simple enough, it has significant practical implications for land uses that are significantly different from those that are able to utilise some of the existing infrastructure on the farm or in the region.

Forestry and dairy enterprises, for instance, are reliant on being relatively close to processing facilities, as transporting the products from the farm becomes prohibitively expensive relatively quickly. Thus land use changes derived by these industries are likely to be characterised by very large but infrequent expansions or contractions (step changes), interspersed with marginal changes within their regions. Large areas of the south of WA have experienced large expansions in plantation forestry at the expense of grazing and some crop production.

There are several broad categories of factors likely to induce land use change within agricultural areas that are of interest to this study. They can be summarised as:

- Agricultural commodity markets, including markets that cover carbon, biodiversity and water.
- Changes to land use technologies, such as tillage practices, plant and animal genetics, etc.
- Changes to the government policies that may favour one activity over another, such as the tax treatment of investment schemes (MISs), transaction costs (such as stamp duty) or compliance costs (such as environmental impact assessments) or the restrictions on access to markets.

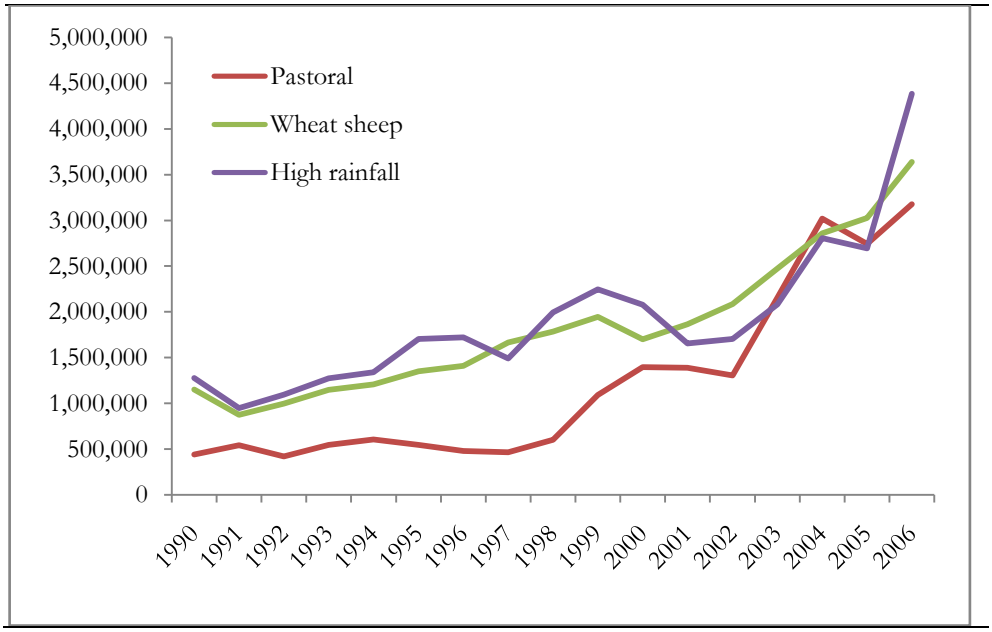
Growing environmental awareness, which essentially is an increase in the value society puts on the preservation of biodiversity and the maintenance of ecological systems, has led to a wide range of policies to induce activities in this area from land holders. The National Heritage Trust has been the principal

source of funding for this policy in Australia. It has subsidised the protection of native vegetation and replanting of extensive areas of, not only trees, but a wide range of native plant species, including native shrubs that make up the understory of native forests. This is an example of governments providing incentives for land holders to change practices to reduce externalities, such as salinity, biodiversity and water quality—clearly analogous to the animal welfare externalities.

An example of the land use changes that result from technology changes in the cropping industry is minimum tillage farming, practiced mainly on soils prone to structural decline. Minimum tillage allows such soils to be cropped, or cropped for longer periods, and help existing soils to retain more moisture. In some instances minimum tillage may also reduce costs, making cropping more competitive with other land uses.

Competition for land for alternative uses has been strong in Western Australia. As can be seen in Chart 1, the value of Western Australian farm land in the wheat, sheep and high rainfall zones has trended up from 1998, with steep rises since 2003. Throughout much of the 1990s land values were static at best.

Chart 1 **Land values in Western Australia ($ real per farm)**



Data source: (ABARE farm surveys n.d.)

The increase reflects land price increases in other agricultural regions of Australia over this period. The drivers most likely to affect land use change in the medium term are:

- Continuation of the current volatility in a wide range of commodity prices, in particularly the extent and persistence of the recent slowing in growth of

a number of Australia's major trading partners due to recent events in financial markets

- Climate change and the capacity of existing industry to adjust to projected climate changes in relation to other land uses
- Policy responses to climate change, such as an emissions trading scheme, and what inputs and industries this is likely to affect.

6 What are the trends in WA sheep and agricultural production?

When analysing the impact of a particular decision or event in an industry, it is important to develop an understanding of the relevant trends in that industry. This involves separating the 'noise', or normal short term variations in the industry, from the underlying structural trends. This allows a robust counter-factual to be developed to provide some perception of the relative sizes of the effects of the event or the decision being analysed.

Development of the counter-factual is critical to an assessment of the impact of any event or decision, as it provides the base line against which the effects of the event or decision can be compared. In this case, the counterfactual requires an assessment of the trends in the Western Australian sheep industry where live exports are not constrained or banned by the Australian Government. This does not mean that the Government will not monitor the industry and intervene in the future if the welfare of the export sheep does not meet the standards current at the time. The industry is also prone to foreign Government intervention, which must be considered in the counter-factual.

Australia-wide sheep numbers have been declining due to a string of below average rainfall years, declining wool prices and higher productivity gains in other enterprises, particularly cropping. Western Australia has experienced a similar decline in the sheep population:

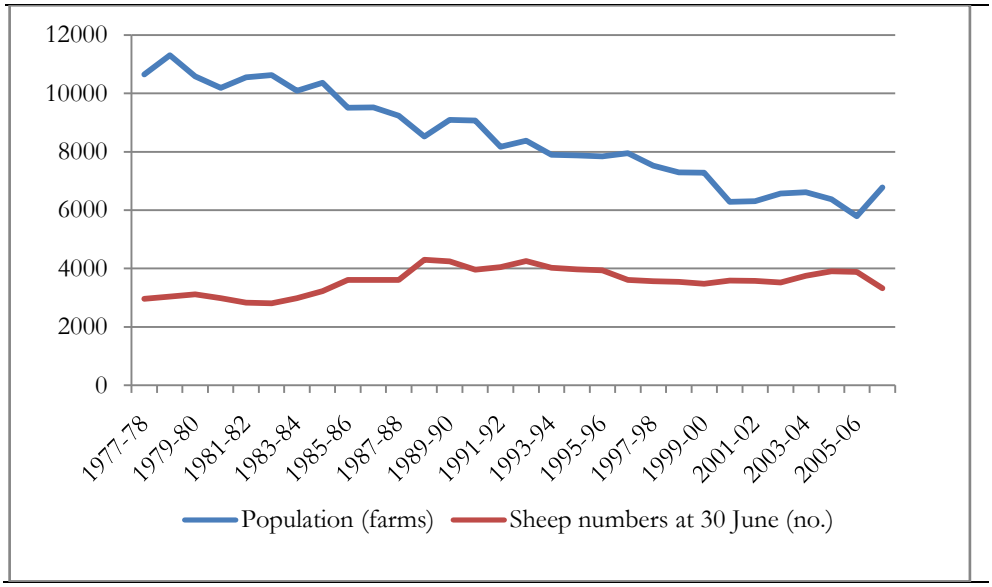
> We attribute this decline [sheep numbers] to the weakening returns from livestock relative to cropping, in addition to the higher and more consistent workload required in a livestock enterprise, which is less appealing to young farmers. During this last year [2006-07] sheep prices have fallen to $46/hd, reflecting the destocking that appears to be happening across much of the wheat belt (Planfarm, Bankwest 2008).

The most significant aspect of the sheep industry in Western Australia for this report is the consistent decline in sheep and farm numbers over the last 10 years. This is illustrated by the data in Chart 2.

The combination of a decline in farm numbers and a static or slight fall in numbers of sheep per farm, indicates that:

- Sheep numbers are falling across the state (fewer farms x same number of sheep per farm = less sheep)
- The contribution of sheep to the gross receipts of farms has been falling (assuming no significant longer term rise in the price of sheep outputs).

Chart 2 **Number of farms and number of sheep per farm in Western Australia**



Data source: (Australian Bureau of Agricultural and Resource Economics 2008)

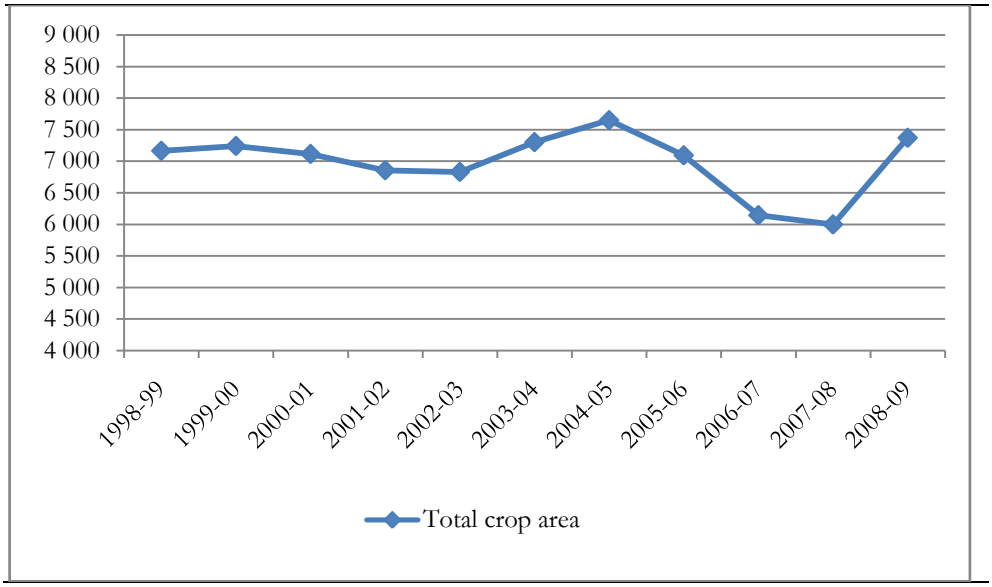
The consolidation of farms and the static number of sheep per farm means that farms are getting bigger (attempting to capture economies of scale) but without increasing the number of sheep per farm.

The farms that are expanding are likely to be those achieving a higher rate of return. This suggests that, on average, the farms that rely less on sheep income are expanding, at the expense of those that rely on a larger proportion of their income being generated by the sheep enterprise.

The decline in sheep numbers is popularly attributed to an increase in crop area, although this does not appear well-founded in the long term if the data in the following chart is accurate.

In this chart WA crop area rose between 2001-02 and 2004-05 and fell significantly between 2004-05 and 2007-08. This suggests that the area of crop is measured by area planted or harvested. This area could be significantly different to the area intended to be cropped, but is prevented from being where some parts cannot be sown or harvested due to seasonal conditions.

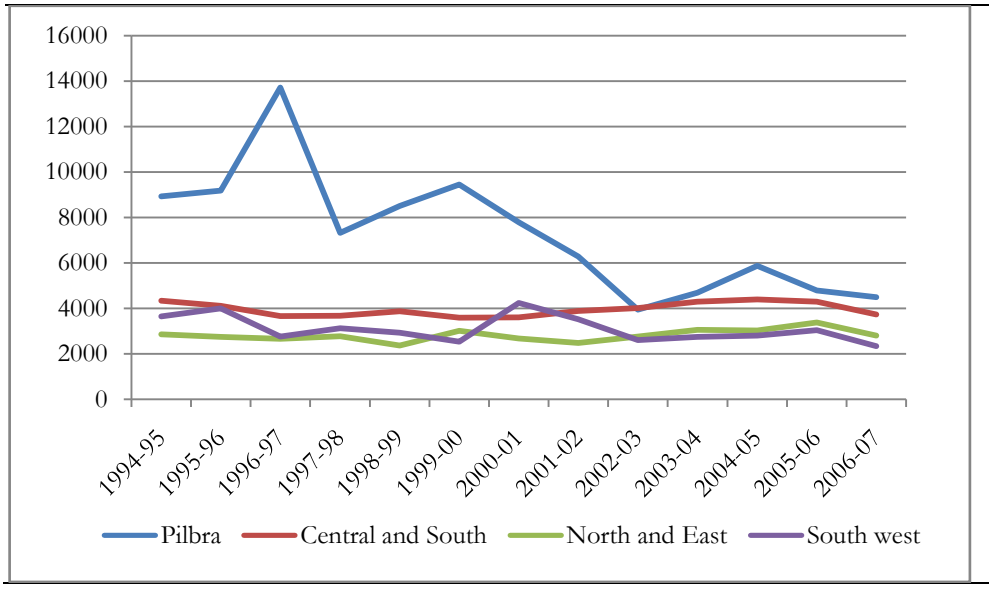
Chart 3 **Total WA crop area ('000 ha)**



Data ABARE 2008

The decline in sheep numbers across WA is likely to be due to a combination of seasonal conditions and an expansion of crop area. If WA has experienced a step change in climate, and a subsequent reduction in annual average rainfall, both the shift to cropping and the reduction in sheep numbers represent significant structural adjustments in the WA sheep industry.

Chart 4 **Total number of sheep per farm as of June 30, various WA regions**

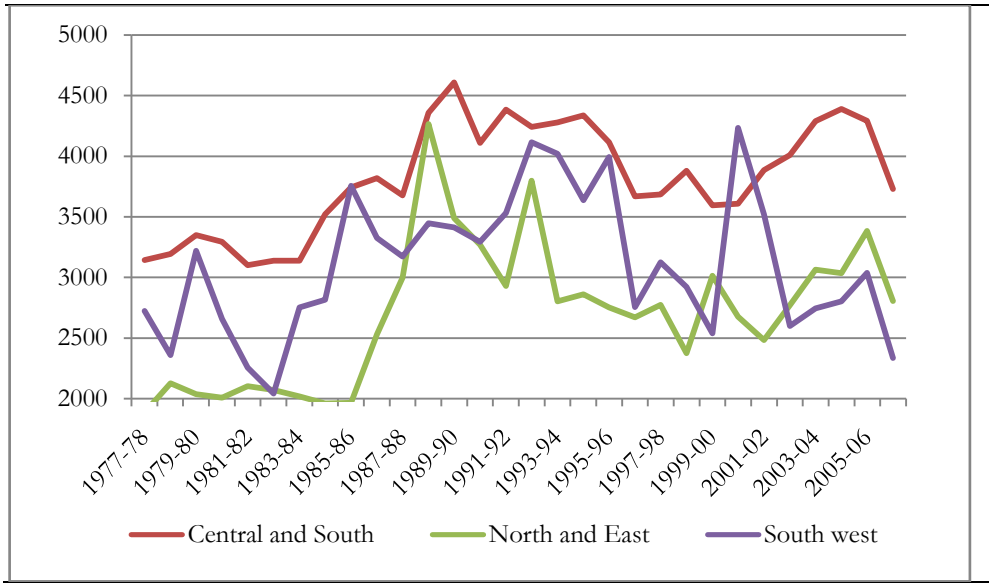


Data source: (Australian Bureau of Agricultural and Resource Economics 2008)

The fall in sheep number is not universal across the state. Some areas have experienced large falls, such as the Pilbara, while other areas appear to have relatively static sheep populations in the medium term. All regions have

experienced a decline in sheep numbers per farm over the last 2 -3 years. This recent trend can be seen in Chart 4 and at a higher resolution in Chart 5 below.

Chart 5 **Number of sheep per farm for selected regions in WA**



Data source: (Australian Bureau of Agricultural and Resource Economics 2008)

An interesting feature of the data in Chart 5 is the considerable volatility in the number of sheep per farm over the period. While some of this volatility can be attributed to 'noise' in the sampling, there appear to be big swings in the number of sheep, driven mostly by seasonal conditions and livestock prices.

The trends in the WA sheep industry can be summarised as follows:

- Overall there has been a consistent decline in the number of sheep per farm and across the state as a whole
- There is considerable volatility in sheep numbers per farm due to seasonal conditions and the relative prices of sheep and wool
- There has been a steep decline in sheep numbers recently, driven by seasonal conditions and the recent rise in cereal and oilseed prices (more recent price falls may halt this trend)
- Disposal of sheep, including for slaughter and live export, has played an important role in this adjustment process.

The implications of the trends in the WA sheep data are:

- A continued decline in sheep numbers will have implications for the medium to long term utilisation of sheep infrastructure on and off farm (including abattoir utilisation).
- Sheep numbers as a proportion of farm receipts are likely to fall further, particularly if the flock dispersal trends are reversed due to improvements in seasonal conditions as sheep are retained on farm and not sold. Eventually stock sales would resume at or above previous levels

- The volatility in sheep numbers per farm appears to far outweigh the adjustments that would be required if the live export markets are closed. This is discussed in more detail in the following section.

7 What effect would the cessation of trade have on sheep meat prices and demand for WA sheep products

This section is based on an unpublished scoping study conducted prior to this report. The assumptions made in this section are tested further in the sensitivity analysis in a later section of this report.

Worldwide consumption of red meat, including sheep meats, is growing strongly, as consumers in the BRIC countries (Brazil, Russia, India and China) become wealthier and substitute plant proteins for animal proteins. This process is likely to resume once the effects of the global financial market turmoil begin to abate. Steady population growth underpins consumer demand, smoothing the effects of economic cycles.

There are strong religious and cultural reasons for a proportion of the sheep meat consumed in the Middle East to be killed domestically. Domestic and regional production cannot satisfy this demand and the Middle East is likely to remain a net importer of live sheep.

If the exportation of live sheep from Australia were to cease, there would be a number of demand responses. They can be summarised as:

- A strong demand for live sheep from other sources, such as Africa, Turkey, India and China, to be substituted for a proportion of Australia's exports;
- Some of the current live sheep demand would be replaced by chilled or processed meat products from Australia. Previous disruptions to the live sheep trade suggest that the level of substitution could be as high as 1.0 million live sheep equivalents (LSE); and
- As other countries move to fill the gap in live sheep supplies left by Australia, their current markets could demand additional sheep meats (mutton and lamb). The equivalent of current Australian live sheep exports could be redirected to these markets as chilled meats.

Substitution and trade diversion could be undertaken at relatively low adjustment costs for Australian producers and with limited impact on the economy.

Overall, there is unlikely to be a dramatic or sustained impact on the price of mutton or lamb in Australia if the live export market could no longer be accessed by Australian producers.

This analysis has assumed no change in the price for sheep meats over the longer term, provided live exporting is phased-out over a 4 or 5 year period (see section 10).

8 What role does the live sheep trade play in WA farming systems?

On average the contributions sheep sales make to gross farm receipts are small. This is particularly so for the top 25 per cent of farms, when assessed on farm operating surplus per ha (Planfarm, Bankwest 2008).

However, assessing the contribution of the value of live sheep sales to gross farm receipts alone may understate the value this market contributes to WA sheep farms.

To build an understanding of the role that live sheep exports play on Western Australian sheep farms, this section will consider two aspects of the farm level effects of the live sheep trade:

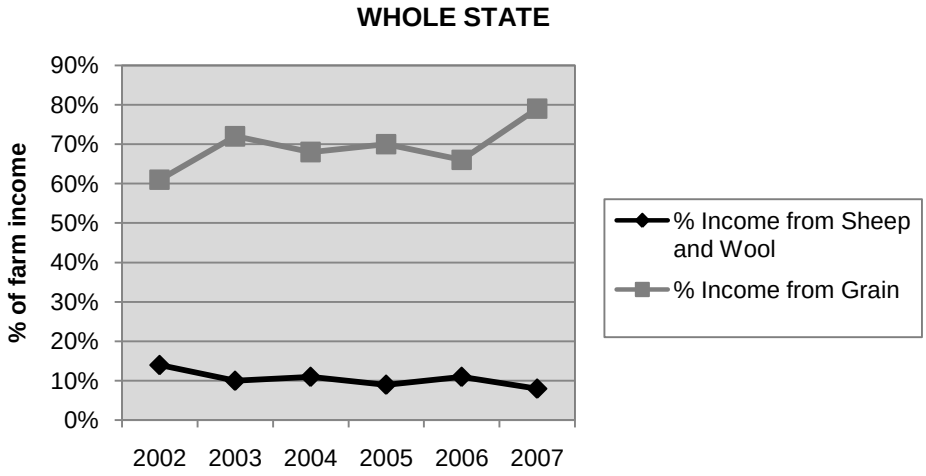
- Gross and net sales of live sheep as a proportion of total sheep sales and gross farm receipts
- The decisions that are made on the basis that this market is available and how this affects the production of a range of other products.

8.1 Gross and net sale receipts of live sheep

What effect is the decline in sheep numbers having on the role that live sheep play on the farm? The first effect is that sheep sales as a proportion of gross receipts may stay constant as sheep numbers fall and the breeding flock is reduced. That is, during a period of flock reduction sheep sales are likely to remain at least constant, or even rise, as the sheep are sold off. Once the sheep numbers stabilise, sheep sales will fall. They will fall dramatically if the industry begins to rebuild the flock.

Sheep sales as a proportion of farm income may also fall if other sources of income rise. The data in Chart 6 shows a slow overall decline in the percentage of income from sheep and a corresponding rise in the proportion from crop income.

Chart 6 **Proportion of sheep sales and crop income of total farm income**



Data source: (Planfarm, Bankwest 2008)

The proportion of sheep and wool income in total farm receipts for 2007-08 is shown in Table 2. This table shows that across a number of regions in WA, sheep income was between 10 and 15 per cent of total farm income. The only region experiencing a higher proportion was the high rainfall southern region (HRFS), which has a higher proportion of farms producing prime lambs.

Table 2 **Analysis of regional performance - 2007/08 season**

	HRFN	HRFS	MRFN	MRFS	LRFN	LRFS	State average
Sheep and wool % farm income	15%	28%	8%	15%	12%	10%	15%

Note: HRF=high rain fall, MRF=medium rainfall, LRF=low rainfall, N=north, S=South
Data source: *(Planfarm, Bankwest 2008)*

The proportion of total sheep sales to total farm receipts is also reported in ABARE's farm survey reports. The data in Table 3 shows that the proportion of total farm receipts represented by sheep sales is broadly consistent with the Planfarm-Bankwest benchmarking results. In addition to total sheep sales, ABARE's farm surveys show live export sales as a proportion of total farm receipts. According to ABARE, live export sheep sales contributed approximately 3 to 4 per cent of total farm receipts between 2000-01 and 2004-05, rising to 7 per cent in 2005-06.

Table 3 **Financial performance of Western Australian broad acre farms with more than 300 sheep (average per property, financial estimates are in real terms expressed in 2006-07 dollars)**

		2000-01	SE	2001-02	SE	2002-03	SE	2003-04	SE	2004-05	SE	2005-06	SE
Physical													
Areas operated at 30 June	ha	9450	(27)	9432	(21)	3810	(28)	4730	(26)	7240	(14)	4576	(20)
Sheep at 30 June	no	3606	(7)	3715	(7)	3723	(8)	3859	(10)	3926	(11)	3882	(9)
Sheep sold													
-total	no	1519	(9)	1395	(8)	1325	(7)	1361	(9)	1396	(9)	1744	(11)
-for live export	no	343	(20)	353	(17)	156	(22)	299	(19)	367	(19)	691	(25)
turnoff rate a		41	(8)	38	(8)	37	(8)	40	(8)	36	(7)	45	(9)
Average sheep price													
-sold live export	**$/hd**	**33**	**(4)**	**53**	**|(4)**	**73**	**(13)**	**56**	**(4)**	**49**	**(4)**	**51**	**(3)**
-sold to other markets	$/hd	30	(12)	49	(6)	54	(6)	61	(4)	52	(4)	53	(4)
Receipts													
sheep receipts	$	47197	(16)	69519	(10)	74000	(9)	81489	(9)	71793	(10)	90708	(11)
proportion of receipts from live export sales	%	**3**	**(21)**	**4**	**(18)**	**2**	**(23)**	**3**	**(17)**	**3**	**(15)**	**7**	**(22)**
Total cash receipts	$	347273	(6)	507062	(5)	518618	(7)	601492	(7)	558373	(6)	503199	(7)
Costs													
Sheep purchases	$	5609	(16)	11186	(18)	15085	(14)	18107	(18)	12913	(19)	18426	(23)
Total cash costs	$	310209	(6)	365992	(5)	400171	(5)	419156	(7)	450497	(7)	422828	(8)
Financial performance													
Farm cash income	$	37064	(33)	141069	(12)	118447	(18)	182336	(12)	107876	(14)	80371	(21)
Farm business profit	$	-63792	(23)	64131	(24)	39148	(52)	107324	(18)	14164	(120)	-24142	(68)
Rate of return b													
-excl. capital appreciation	%	–1.4	(50)	4.3	(15)	3	(25)	4.8	(14)	1.7	(26)	**0.8**	(45)
-incl. capital appreciation	%	2.5	(39)	8.6	(10)	9.1	(11)	15.2	(11)	10	(17)	12.2	(34)
Estimate of population of properties	no	6250		5944		5897		6330		6292		5790	

a includes sheep transferred to other properties. b Calculated as farm business profit adjusted to full equity as a percentage of total opening farm capital

Note: Figures in parentheses are standard errors (SE) expressed as a percentage of the estimates provided

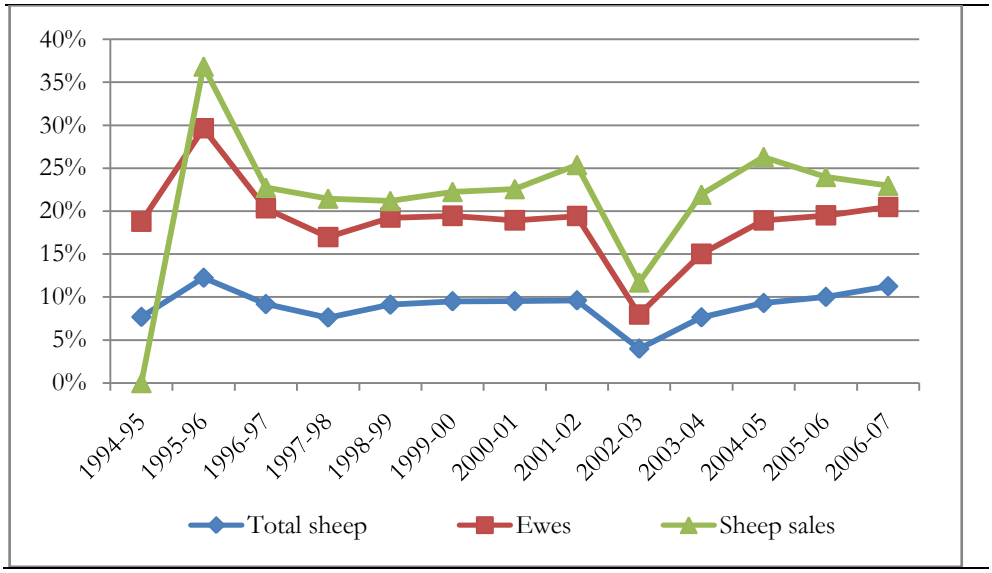
Data source: *(Drum and Gunning-Trant 2008)*

The data in Chart 7 shows the proportion of live export sheep sales to other classes of sheep based on ABARE's farm survey data (Australian Bureau of Agricultural and Resource Economics 2008). The data illustrates an important

aspect of the role that live sheep play. That is the proportion of total sheep numbers exported as live sheep, apart from two large deviations, appears relatively constant. This is not surprising as live sheep are a product of a farming system and their production is dependent on the total number of sheep and the number of ewes in the flock.

An addition important message from this table is the small proportion of total farm receipts live sheep contribute on average.

Chart 7 **Live sheep sales as a percentage of other sheep classes**

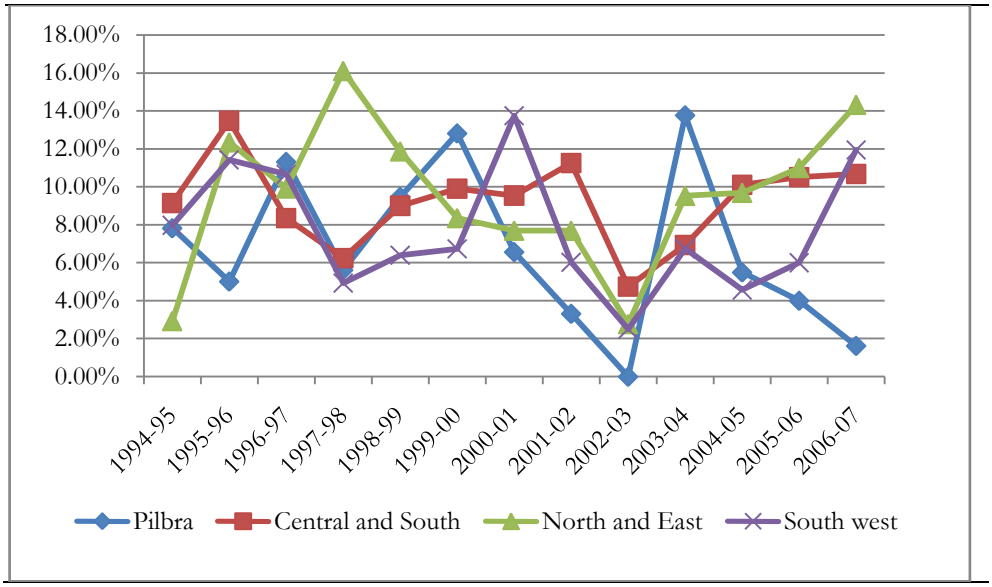


Data source: (Australian Bureau of Agricultural and Resource Economics 2008)

The data in Chart 8shows the considerable regional variations of the live sheep proportion of total sheep on the farm. This variability is smoothed when the data is aggregated as in Chart 7. The smoothing effect of aggregation suggests that when sheep become scarce in one region, they can be sourced from another. This may be due to variations in seasonal conditions across the state.

The large swings in 1995-96 and 2002-03 are due to external factors affecting the live sheep export market, such as the resumption or cessation of trade to Saudi Arabia or severe drought affecting the whole state.

Chart 8 **Number of live sheep sold as a percentage of total sheep as of June 30 for various regions in WA**



Data source: (Australian Bureau of Agricultural and Resource Economics 2008)

The data in Table 4 is from the Planfarm Bankwest 2007-08 farm benchmarking report. The population of this survey is over 500 farm businesses across Western Australia. Their businesses are clients of Planfarm, a farm business consultancy firm and customers of Bankwest.

The data in this table shows the sales, purchases and net sheep sales for all of the regions in the survey between 2002 and 2007, including the results for the top 25 per cent of farms assessed by size of operating surplus in 2007-08. Over this period there were considerable differences in the proportions of total annual average rainfall received between the regions.

Table 4 **Annual per farm sheep sales and purchases selected regions in WA**

		2002	2003	2004	2005	2006	2007		Top 25% group	
							$/ha	%	$/ha	%
HRFN	Sales	58.02	46.43	45.14	43.19	33.30	27.77	7.2	55.18	8.22
	Purchases	10.87	7.64	7.38	7.22	5.96	3.17	0.8	5.26	0.78
Net sheep sales		**47.15**	**38.79**	**37.76**	**35.97**	**27.34**	**24.60**	**6.4**	**49.92**	**7.44**
% of farm operating surplus		30.32	29.85	41.98	46.00	278.41	15.42		13.58	
HRFS	Sales	80.02	86.53	70.95	82.80	53.87	61.86	11.0	67.61	7.85
	Purchases	12.20	16.20	15.09	17.60	7.48	12.84	2.3	11.61	1.35
Net sheep sales		**67.82**	**70.33**	**55.86**	**65.20**	**46.39**	**49.02**	**8.7**	**56.0**	**6.50**
% of farm operating surplus		36.61	54.6	61.74	61.76	63.76	18.52		11.93	
MRFN	Sales	22.54	26.89	24.01	21.56	19.61	15.05	4.0	18.32	2.86
	Purchases	4.69	4.73	4.42	4.00	3.75	1.70	0.5	2.57	0.40
Net sheep sales		**17.85**	**22.16**	**19.59**	**17.56**	**15.86**	**13.35**	**3.5**	**15.75**	**2.46**

		2002	2003	2004	2005	2006	2007		Top 25% group	
							$/ha	%	$/ha	%
% of farm operating surplus		27.92	11.72	23.77	19.67	591.79	8.22		4.33	
MRFS	Sales	33.71	33.58	29.20	34.47	37.56	30.31	6.2	28.78	3.92
	Purchases	7.22	6.98	5.42	6.95	8.73	6.90	1.4	6.32	0.86
Net sheep sales		**26.49**	**26.60**	**23.78**	**27.52**	**28.83**	**23.41**	**4.8**	**22.46**	**3.06**
% of farm operating surplus		53.11	19.91	39.34	44.21	50.48	272.58		4.86	
LRFN	Sales	13.18	12.45	13.21	12.02	10.28	8.36	6.0	9.61	3.34
	Purchases	3.36	3.94	3.56	2.73	2.01	1.07	0.8	1.32	0.46
Net sheep sales		**9.82**	**8.51**	**9.65**	**9.29**	**8.27**	**7.29**	**5.2**	**8.29**	**2.88**
% of farm operating surplus		-74.00	5.69	38.91	11.31	-56.80	26.58		5.93	
LRFS	Sales	15.68	19.09	17.37	15.67	20.19	11.77	4.2	11.48	2.57
	Purchases	5.07	5.27	5.79	3.02	4.62	2.88	1.0	3.23	0.73
Net sheep sales		**10.61**	**13.82**	**11.58**	**12.65**	**15.57**	**8.89**	**3.2**	**8.25**	**1.84**
% of farm operating surplus		-88.98	11.09	134.65	22.60	25.24	7.89		3.33	

Note: HRF=high rain fall, MRF=medium rainfall, LRF=low rainfall, N=north, S=South

Data source: (Planfarm, Bankwest 2008)

There are some general observations from this data on the role sheep sales play in generating farm income:

- In almost all regions the top 25 per cent of farms (assessed on farm operating surplus) had the lowest proportion of sheep sales to gross income per ha and farm operating surplus.
- There appears to be a correlation between rainfall and the level of sheep sales as a percentage of gross receipts per ha—the lower the rainfall, the lower the percentage of sheep sales as proportion of total gross receipts
- As a general rule, net sheep sales per ha fell in total value between 2002 and 2007
- There is enormous variation in the ratio of farm operating surplus and net sheep sales for all categories, suggesting little correlation between sheep sale performance and financial performance
- Related to the last point, sheep sales (gross and net) are highly consistent between years across the observation period for each group.

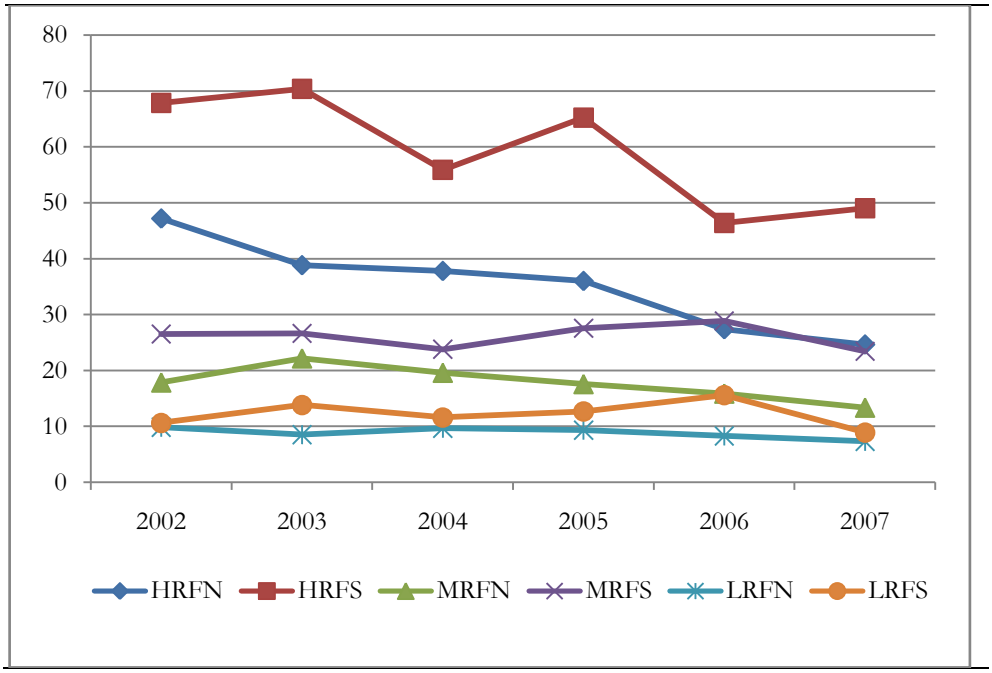
Chart 20 shows the decline in the value of sheep sales per ha from the Planfarm-Bankwest 2007-08 benchmarking results. They show that there has been a steady decline in the value per ha of sheep sales. The reasons for this decline will vary from farm to farm but the common factors are likely to be:

- A decline in the average number of sheep per farm (caused by an expansion of the cropping enterprise and/or a succession of below average rainfall years)
- A decline in the number of sheep suitable for slaughter due to drought. Sheep not suitable for slaughter during extended dry periods may be kept on farm and fed a maintenance ration until seasonal conditions improve.

This reason is likely to be more applicable to northern districts where there are fewer cross-bred sheep.

- Another reason sheep are not sold is to increase stock numbers but this is not likely to be a major reason over this period
- A decline in sheep prices reducing sheep sale value per ha.

Chart 9 **Net sheep income per ha for selected WA regions**



Data source: (Planfarm, Bankwest 2008)

8.2 How farmers would adjust to the cessation of the live export trade

If the live export market was no longer available to WA farmers, the resources that would have been used to produce sheep suitable for this market would be diverted to the next most profitable use. The decision as to what is the next most profitable use of resources would be made based on the consideration of a wide number of factors, including the physical constraints of land, management and labour capacities and an assessment of the market prospects and risks for other commodities and products.

However, live sheep production is a product of a complex farming system that produces wool, lamb and other mutton products. On farms where the land capability includes cropping, the production of cereal and oilseeds would be considered as alternatives to the production of live sheep.

As discussed in section 8.1, the production of live sheep is, on average, the result of a sheep production system producing a range of products. Therefore,

for the average farm, adjustments to the loss of access to the live export market are likely to be iterative (at the margin), rather than significant step changes to the mix of enterprises on the farm.

In this context of the role of live sheep exports in farming systems, five broad scenarios have been considered as part of this analysis. The five scenarios replicate the broad adjustment options sheep producers in WA would face if the live export market were no longer available:

- For sheep-only operations:
  - Finish the sheep that would have been exported live earlier (to reach a higher weight before first teeth are cut to meet lamb market specifications)
  - Keep the wethers until cast (at the end of productive life) primarily to cut wool
  - Increase prime lamb production
- For mixed farming businesses (a mixture of crop and sheep)
  - Increase crop area
  - All of the options open to sheep-only operations

Sheep-only operations are a small part of the WA sheep industry, and are mostly in areas where there are physical constraints on the ability to crop (i.e. too wet or too dry). The overwhelming majority of farm businesses in Western Australia, by number and by volume of production, are mixed farming businesses.

There is a distribution of the contribution of live sheep exports around the average: that is, there are producers that sell a larger or smaller proportion of their stock to this market. However, the number of sheep a producer can sell to the live export market is capped if a static sheep population is to be maintained on the farm.

The stock schedule in Table 5 demonstrates the typical production and movement of sheep for a self replacing merino flock to maintain a static population. The table shows the opening numbers in the far left column and the closing numbers after transfers between age groups in the far right hand column. This typical livestock schedule shows the role that sheep sales play in the typical merino sheep flock and the constraints on the number of sheep that can be sold due to the need to retain ewes for breeding.

Table 5 **Typical merino sheep flock structure and annual schedule**

CLASS		Start	Purchases			Births	Deaths	Sales			End Nos	
		No	Nos	Value/hd	Total	No	No	No	Value/hd	Total	Total	
Ewes	Lambing %				$ -					$ -		
Maidens	80%	600			$ -	480	33			$ -	567	600
2 year	85%	567			$ -	482	31			$ -	536	567
3 year	85%	536			$ -	455	29			$ -	506	536
4 year	85%	507			$ -	431	28			$ -	479	506
5 year	85%	479			$ -	407	26	453	$ 25.00	$ 11,319		479
Total		2689			$ -	2255	148	452.76368		$ 11,319	2088	2688
Wethers					$ -					$ -		
Hoggets		672			$ -		13	659	$ 50.00	$ 32,946		672
Total		672			$ -		13	658.9226		$ 32,946		672
Weaners					$ -					$ -		
Ewes		1066			$ -		59	407	$ 35.00	$ 14,245	600	1066
Wethers		1066			$ -		59	335	$ 55.00	$ 18,425	672	1066
					$ -					$ -		
Total		2132			$ -		117	742		$ 32,670	1272	2131
Rams					$ -					$ -		
Merino		51	12	$ 100	$ 1,200		1	11	$ 45.00	$ 495	51	51
Total		51	12		$1,200		1	11		$ 495	51	51
Merino	E						62			$ -	1066	
Merino	W						62			$ -	1066	
Total							124				2131	
TOTAL		5544	12		$1,200	2255	404	1865	$41.52	$77,430	5543	5543

This flock would typically produce approximately 23,244 kg of greasy wool valued at $130,000. The direct costs of running the flock would be $100,000, including pasture costs but not including labour other than that associated with shearing and crutching. The gross margin produced by this flock would be approximately $70,000. At average WA stocking rates (Planfarm, Bankwest 2008) of 4.65 dry sheep equivalents per ha (dse) the average gross margin return per ha would be $45.70 (over 1530 ha).

Typically the sheep sold for live export would be sourced from the wether hoggets (659) as these sheep are more likely to achieve the weight and condition score specifications for the live sheep market (see Table 1). Some weaner wethers may also be sold for live export but only a small portion would be of sufficient live weight to meet the heavier specifications. Some may be sold as live export lambs in the 34-37 kg lwt range but the prime lamb slaughter market usually competes strongly for this type of sheep.

Theoretically all of the wethers produced by this flock may be sold into the live export market but, in most cases, a proportion, 5 to 10 per cent, may not meet the condition score, live weight or health standards.

If all of the 659 hogget wethers were sold into the live export market, they would contribute approximately 42 per cent of total sheep sales in this example. This may occur if the weaner wethers that would be sold before they

cut their first teeth (at about 14 months of age), are not suitable for the lamb market (due to drought) and would be held over to gain weight and sold to the live export market. This would increase the proportion of live export sheep sales to total sheep sales from 42 per cent to 63 per cent in this example. This raises an important contribution the live export market makes to the sheep industry: this market provides a marketing alternative if seasonal conditions prevent (or make it too costly) to deliver sheep to higher value lamb markets.

The data in Table 5 shows the total number of live export sheep as a percentage of total sheep disposals state wide. The state average is close to 40 per cent and is consistent with the sheep schedule example in Table 6. The data in Table 6 also shows a 5.0 million head decline in sheep numbers between 2004-05 and 2006-07. Over the same period, live sheep exports increased by 540,000.

Table 6 **Western Australian sheep meat statistics**

	2003-04	2004-05	2005-06	2006-07	2007-08(f)
Numbers at 30 June ('000)	25,063	25,592	23,042	21,500(f)	21,500
Sheep Slaughtered ('000)	1,845	2,205	2,121	2,614	1,800
Lambs slaughtered ('000)	2,392	2,467	2,798	2,523	2,200
Sheep/lambs exported ('000)	2,733	2,792	3,401	3,332	2,700
Turnoff ('000)	6,970	7,464	8,320	8,469	6,700
Live sheep % of turn-off	40%	37%	41%	39%	40%
Mutton produced ('000 t) (c.w.)	37.1	43.8	45.9	53.6	37.0
Lamb produced ('000 t) (c.w.)	47.2	49.1	58.1	50.6	44.0
Gross value of WA sheep meat and live exports ($m)					
-lamb and mutton	193	210	241	235	-
-live exports	188	177	234	232	-
Total	**381**	**387**	**476**	**467**	**-**
Live exports as a proportion of the total	**49%**	**46%**	**49%**	**50%**	

Note: (f) = forecast, (c.w.) = carcase weight

Data source: (WA Department of Primary Industries 2007)

This simple livestock schedule and gross margin illustrates several important aspects of the contribution the live sheep market makes to the WA sheep industry:

- The live sheep could account for up to approximately 42 per cent of dispersals for a typical merino flock
- The proportion of live sheep sales is likely to be capped at approximately 60 per cent (if only male sheep are exported)
- The live sheep trade provides a useful market for sheep that do not make higher value market specifications, such as the merino lamb market.

8.2.1 Using a real options framework

A real options methodology has been used to calculate the difference in enterprise value, with and without access to the live sheep trade, for a number of typical Western Australian sheep production scenarios.

Real options valuation methods provide an estimate of the value of the opportunity, but not the obligation to take a particular course of action. Typically, real option values rise as uncertainty rises. In this case real options can be used to value the right, but not the obligation, that WA sheep producers currently have to sell sheep into the live sheep trade.

Therefore while live sheep only play a small role in actual farm receipts, access to this market influences whole of enterprise decisions. For a more detailed discussion of real options see appendix A-1.

Access to this market will influence the way in which farmers manage the use of the resources of the farm where sheep are, or could be, part of the farming system. That is, having access to this market will influence the breeding, culling, pasture management and genetics decisions of the farm manager for the whole enterprise.

The following sections look in detail at the management decisions made by farmers and how reduced and even no access to this market will affect both sheep-only and mixed sheep-farming systems.

8.3 Farm level adjustments

Before sheep are sold into the live export trade, a farmer makes a series of decisions on how many will be sold and when. Intuitively the farmer will also take into consideration a number of competing opportunities (the opportunity cost) for the resources used to produce the sheep that will be suitable for the live export trade. The decisions the farmer makes will also be influenced by a range of factors beyond his control, such as:

- the amount of feed available to graze the sheep
- the price prospects for various market opportunities
- the condition of the sheep (including the wide distribution of condition scores expected in any mob).

8.3.1 The wether production system

The adjustment that would be required for a sheep production system where a portion of wethers are retained for wool is the simplest to model. In this scenario, when faced the loss of access to the live export market, the decision facing the farmer is either increasing the proportion of sheep that would be

sold into higher value lamb markets or retaining more wethers for wool production. The decision to sell into higher value lamb markets means that the sheep would need to be of a weight suitable for slaughter before the first adult teeth are cut, at approximately 14 months of age. Once the teeth are cut, a wether is no longer considered a lamb and the price per kg can fall by as much as $1.00 per kg.

Where wethers are retained in the sheep production system for cutting wool, they are typically kept until 5 or 6 years of age and then sold (when they are called 'cast for age'). At this age these sheep have reached the end of their productive life and are sold into the meat processing market.

There are five possible outcomes for merino wethers in this system:

1. Sold at 6 to 8 months as a merino prime lamb (usually only a small proportion of the wether drop are likely to be heavy enough for this market)
2. Sold at 10 to 12 months into the merino prime lamb market (usually the wethers not heavy enough to make the 6 to 8 month category can make this market with some preferential feeding, such as fodder crops or high quality pasture)
3. Selected to be retained for wool production. These sheep are the remaining wethers after the initial lambs have been sold. Typically, they will be held until the first shearing and classed up. The wethers with superior wool (quantity and quality) will be kept and the rest sold. This is likely to occur between 18 and 24 months.
4. The wethers that are not to be retained will be sold. The heavier sheep are suitable for the live export trade.
5. A small proportion of the sheep that are not suitable for the live export market (usually too light or a condition score below 2) will be sold for slaughter and processed into manufactured mutton products.

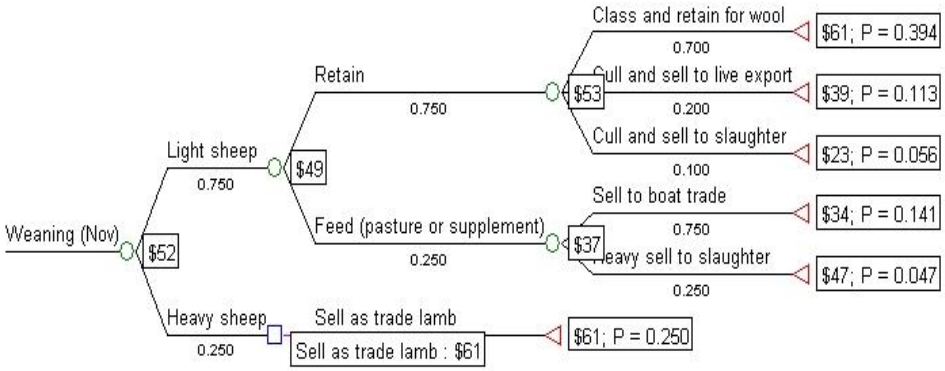
The following decision tree diagram (Chart 10) scans from left to right, depicting each chance node where sheep are either sold or move through to the next point. The triangles on the final branch are the terminal branches and are assigned the net present value (NPV) for each of the outcomes (the calculations for each of these NPVs are in sequential order in appendix B).

Each of the NPV calculations takes into account all of the direct income and expenditure incurred per month for each of the possible outcomes. This includes additional pasture and direct labour costs, animal health, shearing and crutching. It also includes wool and sheep sale value. Thus all of the additional income and expenditure for each possible outcome is included in the NPV calculation.

The values at each of the branches in this decision tree are the NPV, weighted by the probability of this event occurring. The outcomes are not purely chance but are a combination of the normal distribution of the sheep within the flock, the seasonal conditions at the time and a range of other management considerations.

The expected value of this range of possible outcomes for the merino wether is $52.00.

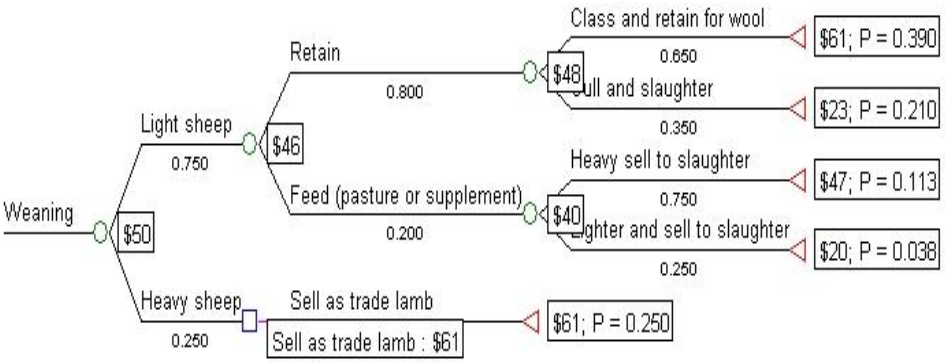
Chart 10 **Wether enterprise decision tree with live export sale option**



The decision tree in Chart 11 shows the same merino wether scenario as in Chart 10 but without the option to deliver to the live export trade. In both charts, the same number of wethers is retained until cast for age (that is no land use change decisions are included such an increase in ewe numbers or a shift to cropping).

The first effect of removal of the live sheep market option is that the farmer would be reluctant to incur the additional costs of preferentially feeding the heavy sheep that did not make the prime merino lamb market specifications. In this scenario, the farm does not have the live sheep trade to accept its sheep if they do not make the lamb specification before cutting their first two teeth. Thus the farmer will reduce the number of additional sheep he will provide with preferential or supplementary feed.

Chart 11 **Wether enterprise decision tree with no live export sales option**



Therefore fewer sheep will be fed to make the heavy (sell to slaughter) market and more sheep will be retained for classing and possible retention for wool production. This means that more sheep will be classed and, if the final number retained remains the same, more sheep will be sold into the slaughter market at a lower value than for the live export sheep market.

This modelling does not assume any difference in slaughter sheep prices, as the results of the first stage of this analysis concluded that there would be negligible changes in the value of mutton as a result of the cessation of the live export trade (sensitivity to price changes and other factors is analysed in more detail in section 12). This is particularly so where the trade is phased-out over a number of years, with policy mechanisms introduced to manage the process (this is discussed in more detail in section 10).

The expected value of the merino decision tree without the live export option is $50.00, which is a 4 per cent decline in the value the net present value of the wether at or close to weaning. These decision trees show the value of the farmer's option to deliver sheep to the live export market. This does not mean the farmer will deliver any sheep to this market; rather, when considering how many wethers to sell, feed, class and retain, the farmer currently has a marketing option that has some value.

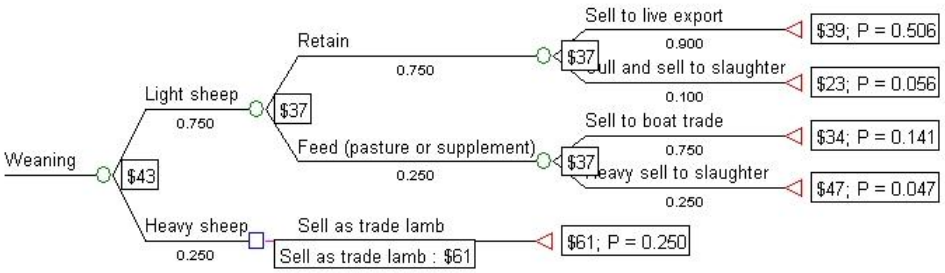
In other words, the value of the option to sell sheep to the live export market in this situation is $2.00 per wether or approximately 4 per cent.

8.3.2 Merino flock with no wethers retained past two years old

Where there are no retained wethers, that is, all of the wethers are sold by 2 to 3 years of age, cessation of the trade is likely to be more costly. This is because there are fewer options for the disposal of the sheep. In this scenario, a farmer may choose to keep the wethers that do not make a prime lamb specification for another year, to obtain another fleece and then they are sold. Under this

scenario it is unlike that large scale land use changes would be induced, rather the flock structure would be altered.

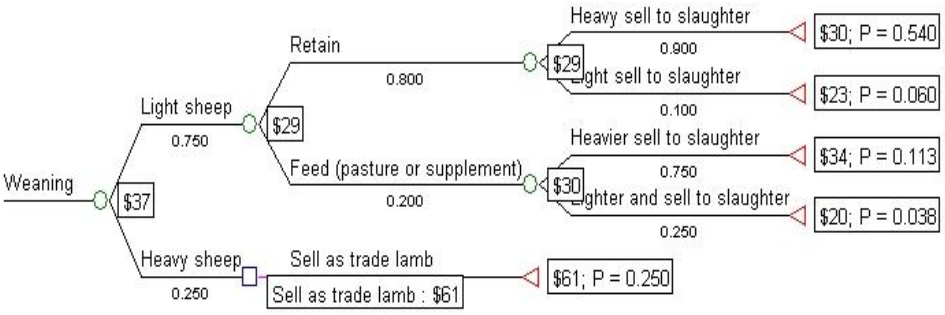
Chart 12 **Merino flock with no retained wethers**



The value of extinguishing the live sheep option in this scenario is $6.00 ($43-$37). This is a 13 per cent fall in the value of the merino enterprise. This depreciation of the enterprise is likely to create a strong incentive to alter land use, such as introduction of cross bred lamb production or increasing the area of crop at the expense of the merino flock.

However, this flock structure is becoming increasingly less common in WA (and Australia generally), as most merino enterprises replace wethers for wool production with ewes mated to cross-bred rams, not with ewes mated to merinos to produce prime merino lambs.

Chart 13 **Merino flock with no retained wethers and no live export option**



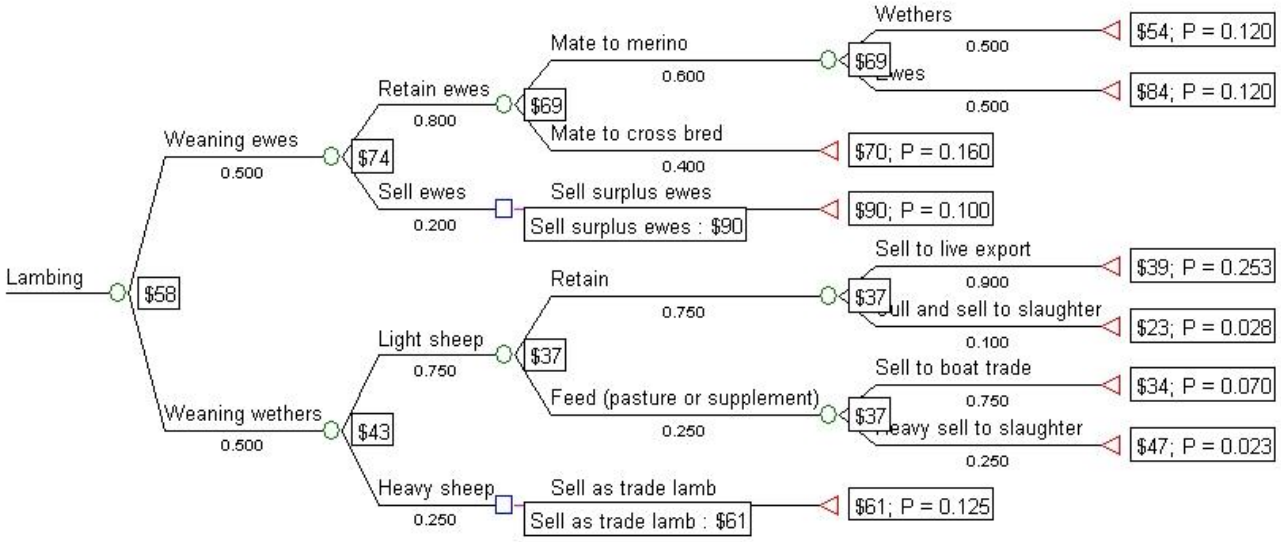
8.3.3 Merino ewe and lamb production system

Retention of a mob of wethers is less common in most sheep production enterprises across Australia, and in particular the sheep-wheat zone. As discussed in the preceding section, in most instances where it is possible to produce prime merino or cross-bred lambs, wethers have been sold and

replaced with ewes to produce prime cross-bred and merino lambs (mostly a combination of the two).

In a merino flock, producing a combination of merino and cross-bred prime lambs, the removal of the option to deliver to the export lamb market is more complex than the effects in a merino flock where no prime lambs are produced.

Chart 14 **Merino and cross bred mating options**

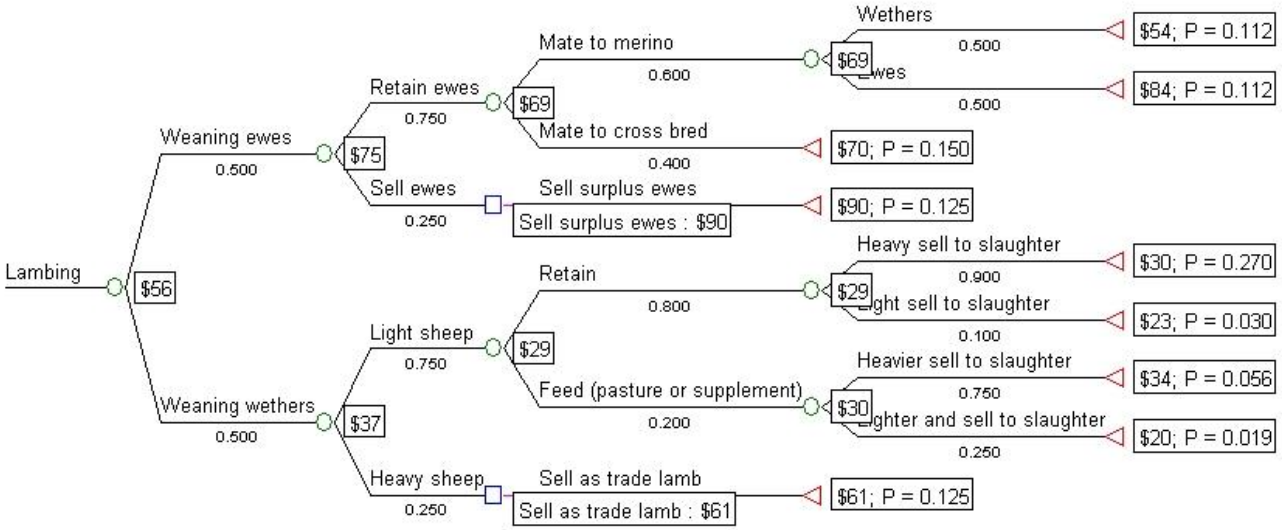


The decline in the value of the merino wether options alters the number of ewes a farmer will retain and how many of those ewes will be mated to cross-bred rams. Where wethers are retained for wool production, fewer ewes would be kept, as the wethers that would have been sold to the export market may be kept longer so that an additional fleece can be produced. This would equate to approximately 5 per cent fewer ewes retained and available for mating to either cross-bred or merino rams.

Alternatively, more ewes may be retained to mate to cross bred rams. The scenario of retaining more wethers of wool production is illustrated in Chart 14.

The effect of removing the live export market option, would be the same in the wether sub-branch as in section 8.3.2. However, the effects on the wether sub-branch diluted by the ewe sub-branch and offset by releasing some additional ewes to be sold after weaning.

Chart 15 **Merino and cross bred mating options with no live export market**



The net effect of removing the live export market from this scenario is $2.00 ($58.00-$56.00) or 3.5 per cent of the current situation.

A reduction of this magnitude is not likely to create an incentive to significantly change land use decisions by replacing ewes with crops. However, some minor shift at the margin may be expected.

8.3.4 Effect on land use change

For mixed farming enterprises, the loss of the option to export live sheep is not likely to create a significant incentive to replace large areas of pasture with crops. The main reason is that the current drivers of land use change, causing increases in crop area at the expense of pastures, appear to overwhelm the effects of losing the live export trade. For instance, the gross margin changes that are likely to result from a change in the flock structures brought about by the loss of this option, are small in comparison to the crop gross margin, as illustrated in the following tables.

Table 7 **Gross margin sensitivity to pasture area and wool price (excluding livestock capital) for self replacing merino flock (no prime lambs) for the eastern wheat belt**

		Wool price – market quote $/kg clean					
		$6.80	$7.30	$7.80	$8.30	$8.80	$9.30
Pasture area (ha) required for this flock	650	46.07	50.60	55.14	59.67	64.20	68.73
	700	40.92	45.13	49.33	53.54	57.75	61.96
	750	36.45	40.38	44.31	48.23	52.16	56.09
	800	32.54	36.22	39.91	43.59	47.27	50.96
	850	29.09	32.56	36.03	39.49	42.96	46.42
Sensitivity of gross margin/ha to total variable costs and wool price (excluding livestock capital)							
		Wool price – market quote $/kg clean					
		$6.80	$7.30	$7.80	$8.30	$8.80	$9.30
Total variable costs (excluding livestock capital)	$41,010	50.12	54.05	57.98	61.90	65.83	69.76
	$46,137	43.28	47.21	51.14	55.07	59.00	62.93
	$51,263	36.45	40.38	44.31	48.23	52.16	56.09
	$56,389	29.61	33.54	37.47	41.40	45.33	49.26
	$61,516	22.78	26.71	30.64	34.56	38.49	42.42

Data source: (Western Australian Department of Primary Industries 2004) updated with 2008-09 prices

The sensitivity analysis for sheep and crops presented in this section us a common format where key variable (yield and price) are altered and the effect of this change of the enterprise gross margin is recorded in a matrix format. The intent of this type of analysis is to show the relative sensitivity of key variables. That is how do the changes in one variable compare to change in another. Another use of sensitivity analyses is to show the combine effect of changes to variables. A combination of a change in yield and price can have a significant impact on the gross margin of an enterprise.

The following tables illustrate clearly the dramatic effect of changes to grain prices and yields have to cropping gross margins. Similarly stock rate and wool price changes have a dramatic effect on sheep enterprise gross margins. These changes appear to be far larger, even with relative small changes to the effect on a sheep enterprise of a cessation of the live export trade in Western Australia.

Table 8 **Wheat gross margin and sensitivity analysis per ha (Narrogin)**

	Wheat Price ($/t net on farm)				
Yield (t/ha)	**$160**	**$180**	**$200**	**$220**	**$240**
1.45	($63)	($34)	($5)	$24	$53
1.85	$1	$38	$75	$112	$149
2.25	$65	$110	$155	$200	$245
2.65	$129	$182	$235	$288	$341
3.05	$193	$254	$315	$376	$437

Data source: (Western Australian Department of Primary Industries 2004)

Table 9 **Canola gross margin and sensitivity analysis per ha (Narrogin)**

	Canola Price ($/t net on farm)				
Yield (t/ha)	**$360**	**$380**	**$400**	**$420**	**$440**
0.7	($73)	($59)	($45)	($31)	($17)
1.1	$71	$93	$115	$137	$159
1.5	$215	$245	$275	$305	$335
1.9	$359	$397	$435	$473	$511
2.3	$503	$549	$595	$641	$687

Data source: (Western Australian Department of Primary Industries 2004)

Table 10 **Barley gross margin and sensitivity analysis per ha (Narrogin)**

	Barley Price ($/t net on farm)				
Yield (t/ha)	**$140**	**$160**	**$180**	**$200**	**$220**
1.7	($60)	($26)	$8	$42	$76
2.1	($4)	$38	$80	$122	$164
2.5	$52	$102	$152	$202	$252
2.9	$108	$166	$224	$282	$340
3.3	$164	$230	$296	$362	$428

Data source: (Western Australian Department of Primary Industries 2004)

Table 11 **Lupin gross margin and sensitivity analysis per ha (Narrogin)**

	Lupin Price ($/t net on farm)				
Yield (t/ha)	**$200**	**$220**	**$240**	**$260**	**$280**
0.7	($49)	($35)	($21)	($7)	$7
1.1	$31	$53	$75	$97	$119
1.5	$111	$141	$171	$201	$231
1.9	$191	$229	$267	$305	$343
2.3	$271	$317	$363	$409	$455

Data source: (Western Australian Department of Primary Industries 2004)

Where the cessation of trade is likely to have the largest effect is where there is limited capacity to change from grazing to prime lamb or crop production. The main reasons why this land use change may be constrained include:

- Significant additional investments in plant and/or labour may be required if existing plant/labour is at full capacity
- There are significant agronomic barriers, such as weed resistance or soil structure and fertility decline that may have been reached by the farm

In these circumstances the full effect of the decline will be felt by the farmer as there are no opportunities to offset the effects by changing land use.

Box 1 **Crop and pasture returns in WA**

A long-term economic study of different crop rotations is casting doubts on the value of volunteer pasture within farming systems in grower trials at Wickepin in Western Australia's central wheat belt.

The study showed continuous barley had the highest gross margin when compared with eight other rotations in this typical 'wheat/sheep' region.

Continuous barley had a cumulative four-year gross margin of $1481 per hectare, slightly ahead of the lupin-wheat-canola-wheat rotation at $1444/ha and vetch-wheat-wheat-wheat at $1346/ha.

Returns for the canola-wheat-pasture-pasture rotation were the lowest at $254/ha.

Sustainable agriculture coordinator for the Facey Group, Tas Larnach, says he is aware of several growers who intend to reduce flock numbers, or sell all of their sheep, because of the strength of their cropping returns.

Group cropping coordinator and Wickepin farmer, Gary Lang, who runs sheep due to a lack of alternatives on some soil types, expects high grain prices to push about 30 per cent of sheep out of the Wickepin district.

In 2005, group members observed significantly higher yields when wheat was planted after lupins and the brown-manured vetch. But there was no rotation influence on yields during 2007.

Mr Larnach says the findings suggest there is little benefit in relying on a legume to lift nutrient levels and that more money could be made by applying fertiliser, despite its higher cost.

In a report on the trial, Narrogin-based Farmanco consultant David McCarthy and Mr Lang, say record grain prices and relatively lower sheep returns had the biggest influence on profits during 2007.

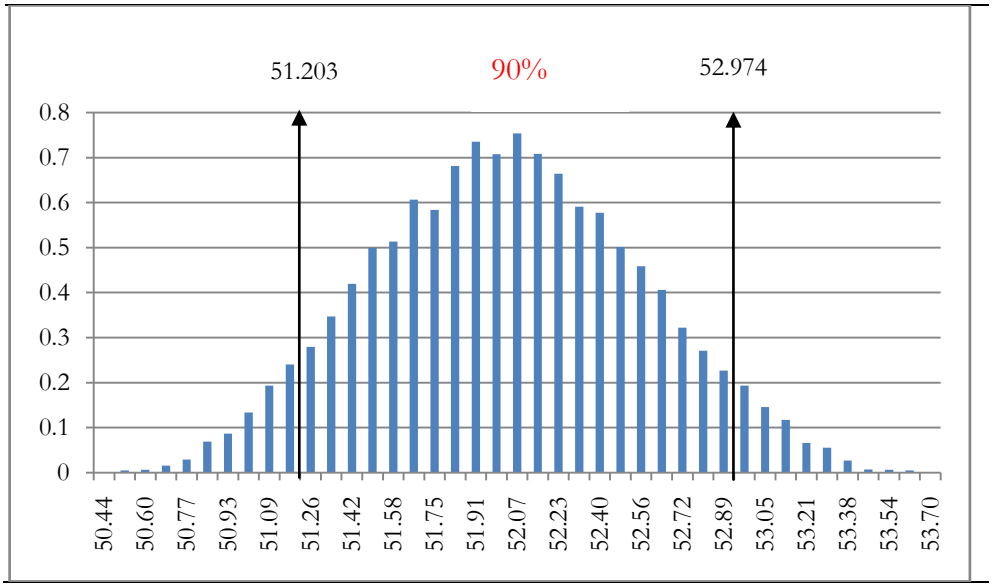
Data source: (Baxter 2008) GRDC web site accessed on the 12/12/2008

9 Sensitivity

An important component of an analysis of this type is to test the level of sensitivity to key assumptions.

The first step is to test how robust the results are. To do this we have chosen the wether only branches of the decision trees used in this analysis. The data in Chart 16 shows the 90% confidence interval regarding the value of a wether. That is, while we estimate the wether to be worth $52.00 with the option of delivery to the live export trade, the probability that the actual value of the lamb is going to lie between $51.20 and $52.97 is 90%.

Chart 16 **Value of wether with 90 per cent confidence**



Data source: ACIL Tasman 2009

This is based on a normal distribution:

- of labour efficiency with one standard deviation being 1,000 dses per labour unit for both with and without live export markets for the wether decision tree calculations
- of carcass value of $0.14 per kilogram for slaughter wethers.

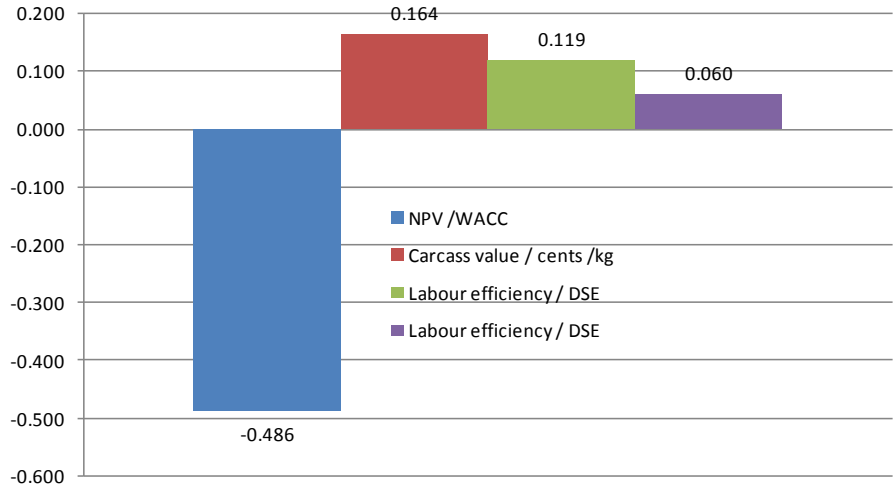
The weighted average cost of capital (WACC) (the costs of the capital employed by the farmer to fund the sheep) sensitivity test used a triangular sensitivity of plus or minus 5 per cent WACC. This means that the results of the WACC sensitivity test are not directly comparable to carcass value and labour efficiency but it does provide a guide as to the relative impact of each assumption.

The result of the sensitivity analysis shows that a change of one standard deviation:

- $0.14/kg change in the carcass value of sheep culled and sold for slaughter would change the value of the sheep by $0.16.
- 1000 units change in labour efficiency in raising light sheep that are culled and sold as live exports changes the value of the sheep by $0.12.
- 1000 units change in labour efficiency in raising light sheep that are culled and sold for slaughter changes the value of a lamb by $0.06.

As mentioned previously the sensitivity to the WACC is not directly comparable but is does show that the wether production system is more sensitive to the cost of capital in these calculations.

Chart 17 **Sensitivity chart**



Data source: ACIL Tasman 2009

The sensitivity test shows that the analysis is sensitive to the value of mutton which could be influenced by a cessation of the trade. However, a 10 per cent fall in the carcass value will only result in a three per cent change in the overall value of the wether. The cost of capital (interest rates and alternative uses of the farmer's capital) is likely to have a much larger influence on the value of the wether.

10 How can the adjustment process be managed to reduce the impact of a cessation of the trade?

This section discusses policy options that could be used to reduce the impact of a cessation of the live export trade. It considers the effects of timing and policy instruments of a market based nature that could reduce the effects of a policy change.

10.1 Policy options for government

There are a number of policy options open to government to reduce the social cost of the trade. One is to mandate increased welfare standards with performance measured by average mortality rates or other measures. If it is assumed that the trade has the incentive to ensure the animals reach their destination in a commercially acceptable condition, any additional welfare conditions applied to the industry will cost in excess of this amount. That means the industry will incur additional costs.

This will mean that either live export margins will fall; farmers will be paid less for the animals, or sheep prices will have to rise. Given the competition for sheep meat (lamb and mutton) is rising it is unlikely that farmers will accept less for the sheep.

Inelasticities in at least a portion of the market for live sheep makes it likely that some of the additional costs could be passed on to consumers. But some substitution is likely so the proportion of addition welfare costs that could be passed on is likely to be limited.

If the welfare costs rise and there is limited scope for the sheep traders to pass the costs on then the number of sheep exported live will fall over time. This is largely the situation in New Zealand.

Another policy option that the government may consider is banning the trade. The rest of this section considers how the costs of banning the trade can be reduced by phasing in transferrable quotas for the sheep that can be exported live during the phase out period.

10.2 Reducing export numbers over time

The costs of adjustment are highly sensitive to the time of cessation of the trade. By phasing-out the live sheep trade over five years, the impact on the Australian economy would be reduced from the $900 million to $1.0 billion expected by Meat and Livestock Australia (MLA) (Clarke, Yates and Morison 2007), to $200 million. This is based on the assumptions used in the MLA report, which contain supply chain costs and considerable price effects based on the assumption of immediate cessation of the trade without any prior warning.

Phasing-out the live sheep market is an important component of the adjustment process, as most production decisions that would produce sheep suitable for the live export market are made one to two years before the sheep are sold.

The case study decision trees used in section 8.3 assume time horizons of between 2 and 5 years.

Given the lead time that would be required for sheep production systems to adjust, a 4 or 5 year phase out of the trade may be required. Using a straight line reduction, a 4 year phase out would require a 0.8 million per annum reduction in the number of sheep exported each year (for Western Australia only). The starting point of this quota could be the average of the last 4 or 5 year's live exports, which for WA is approximately 2.9 million sheep and lambs.

10.3 Allocation of export quota

If the export of live sheep were to be phased-out (subject to annual quota), it raises the question of how access to a diminishing market could be allocated to WA's sheep producers. At present, the market is constrained by the demand of international markets, mostly in the Middle East. All Western Australian farmers have the right to sell to this market.

If the number of sheep were to be constrained by government intervention, at a level that exceeds supply, then the question arises as to who gets access to this market. The simplest way to allocate this quota would be first in first served but this would advantage those farmers able to prepare sheep earlier. There would be little indication at the start of the year when the market would fill. Many producers may produce sheep in the hope of entering this market but may not have the sheep prepared before the quota was filled. When the quota was filled the market would collapse, producing a result little better than an immediate banning of the trade.

There are three options that may allocate the quota more efficiently:

- Auction off the quota allocations at the beginning of each year
- Issue to each producer a share of the quota, pro-rated on the number of sheep they have as a proportion of the total state flock
- Issue the quota pro-rated on the historical number of sheep as a proportion of the total number of sheep sold to the market by each farmer, averaged over the last 4 or 5 years.

These allocations could be made for the whole period in year one or an annual process could be developed.

If a mechanism is provided to allocate the quota each year, farmers will have more certainty as to how many sheep they can deliver to the market and make production decisions accordingly. Also, the efficiency gains of allocating the quota in this way need to be compared to the transaction costs associated with each option.

Auctioning off the quotas would allow those producers most reliant on the live export market (i.e. have the most to lose), to secure the largest share. This would reduce the overall adjustment costs, as the producers with the most to lose would have access to the market for the longest time possible under the phase out process.

The net proceeds (after administration costs) of the auction system could be used to assist producers with production adjustments, such as:

- Improving pasture management to finish sheep earlier, to meet lamb market specifications
- The selection of rams and ewes to meet new market specifications
- Improving risk management capability for sheep producers.

10.3.1 Market based instruments to allow quota to be traded

The efficiency of the quota allocation process could be improved by making the quotas freely tradable. This means that if a producer has obtained an allocation of the live export sheep quota, they are then able to sell this quota, or a portion of it, to other producers. This means that:

- If circumstance change, such as seasonal conditions across the state, those producers who will gain more from having access to the market will seek to buy access rights from those that have other marketing options
- Farmers that can adjust more quickly can sell their quotas to others who take longer to make the required changes
- Animal welfare groups who believe the process is too slow, can enter the market and buy quotas, preventing others from exporting sheep.

The management of quotas can provide a useful mechanism for the process to become partially self funding and reduce the adjustment costs likely to be incurred.

11 Aggregating the effects

The adjustments described in the preceding sections of this report are an estimate of the equity effects of Western Australian sheep producers no longer having access to the live export trade. That is, the change in the value of the sheep that the farmer would otherwise have the option of selling to the live export trade.

In the examples used above, the changes in value for the various types of sheep are:

- Wether enterprise $2.00 per wether (approximately 4.0 per cent)

- Wether enterprise, where no wethers retained past 2 years old $6.00 per wether (approximately 13 per cent)
- Mixed merino and cross-breeding enterprise $2.00 per ewe (approximately 4.0 per cent).

These adjustment costs do not take into account the effect of a transferrable quota system being introduced but do assume at least a short phase-out of the export of live sheep.

As these adjustment costs are based on the net present value of the animal concerned, they are one-off costs. Thus the cessation of the trade would produce a one-off drop in the value of the animals and hence a fall in the value of the asset for those holding sheep at the time the trade ceased.

To estimate the farm level effects of the cessation of the trade, the one-off adjustments are multiplied by the average number of each type of sheep per farm. If the adjustment values are applied to the opening sheep numbers used in Table 5, the change in sheep value is $10,986. When aggregated across WA at current sheep numbers the change in flock value is $74,449,130.

Table 12 **Change in sheep value for a typical sheep enterprise**

		Number	Start Valuation	Total	No trade valuation	
Ewes						
Maidens		600	$52	$31,219	$50	$30,019
2 year		567	$52	$29,484	$50	$28,350
3 year		536	$52	$27,862	$50	$26,791
4 year		507	$52	$26,339	$50	$25,326
5 year		479	$52	$24,914	$50	$23,956
Total		2689		$139,819		$134,441
Wethers						
Hoggets		672	$52	$34,963	$50	$33,619
Total		672		$34,963		$34,963
Weaners						
Ewes		1065	$55	$58,619	$53	$56,487
Wethers		1065	$55	$58,619	$53	$56,487
Total		2131		$117,237		$112,974
Rams						
Merino		51	$500	$25,500	$500	$25,500
Total		51		$25,500		$25,500
TOTAL		5543		$317,519		$306,534

The change in value for the sheep flock used in the example above is 3.46 per cent. This model flock is significantly larger than the average of 3,318 (June 30) sheep of a typical WA farm as reported by ABARE (2008).

The average stock value of the Planfarm benchmarking participants ranges between $214,071 for the top 25 per cent and $169,189 for the bottom. The change in value of the sheep inventory in the Planfarm survey results between February 2007 and February 2008 for the top 25 per cent, was 5.48 per cent and 23.69 per cent for the bottom 25 per cent (Planfarm, Bankwest 2008). This change in inventory is due to a continued decline in sheep numbers, and dry seasonal conditions, rather than a significant change in sheep value per head (see Table 13).

Table 13 **Breakdown of farm capital, whole WA agricultural region**

	Top 25%	Average	Bottom 25%
Opening Values			
Land value	$4,595,816	$4,403,787	$3,851,908
Land Value ($/EFF HA)	$1,632	$1,199	$809
Stock value	$214,071	$213,677	$169,189
Plant	$858,223	$885,409	$985,462
Seeds, Produce & Stores	$286,141	$253,563	$246,170
Pools, Tolls, Credits	$236,719	$220,783	$226,550
Cash Accounts	$92,880	$91,084	$82,636
Total Farm Assets	$6,283,850	$6,068,303	$5,561,914
Total Farm Liabilities	$1,274,106	$1,292,508	$1,193,561
Net Off Farm Assets	$688,084	$821,506	$982,553
Return on Capital (%)	16%	6%	-5%
Debt to Income	0.70	1.52	3.32
Net Business Equity (Feb 2007)	**$5,609,390**	**$5,514,728**	**$5,267,433**
Equity (%) (Feb 2007)	**79%**	**79%**	**79%**
Closing Values			
Land value	$5,189,461	$4,755,960	$3,831,423
Stock value	$202,333	$184,690	$129,113
Plant	$916,101	$901,244	$956,964
Seeds, Produce & Stores	$398,912	$341,581	$315,797
Pools, Tolls, Credits	$455,317	$308,947	$124,528
Cash Accounts	$179,658	$107,225	$77,108
Total Farm Assets	$7,341,782	$6,598,841	$5,434,934
Total Farm Liabilities	$1,328,384	$1,370,109	$1,331,438
Net Off Farm Assets	$744,075	$876,597	$1,003,796
Net Business Equity (Feb 2008)	$6,664,251	$6,010,619	$5,012,300
Equity % (Feb 2008)	**82%**	**79%**	**76%**
Net Farm Equity Change (2007)	**$1,054,861**	**$495,890**	**-$255,133**

Data source: (Planfarm, Bankwest 2008)

A change in the value of the sheep inventory of the magnitude approximated by this study would result in a negligible change in the equity ratio for the Planfarm survey participants, as represented in Table 13.

The focus of this analysis has been on the average farm. Clearly there will be farms that will be more, or less, affected by a cessation of the trade than the average. Information is not publicly available to determine the distribution of specialist live sheep farms. However, from a policy perspective, assuming the distribution of farms about the mean is not skewed to the either to the right or left, the average effect provides a useful assessment of the adjustment costs likely to be incurred in total.

11.1 The effects of a transferrable quota system

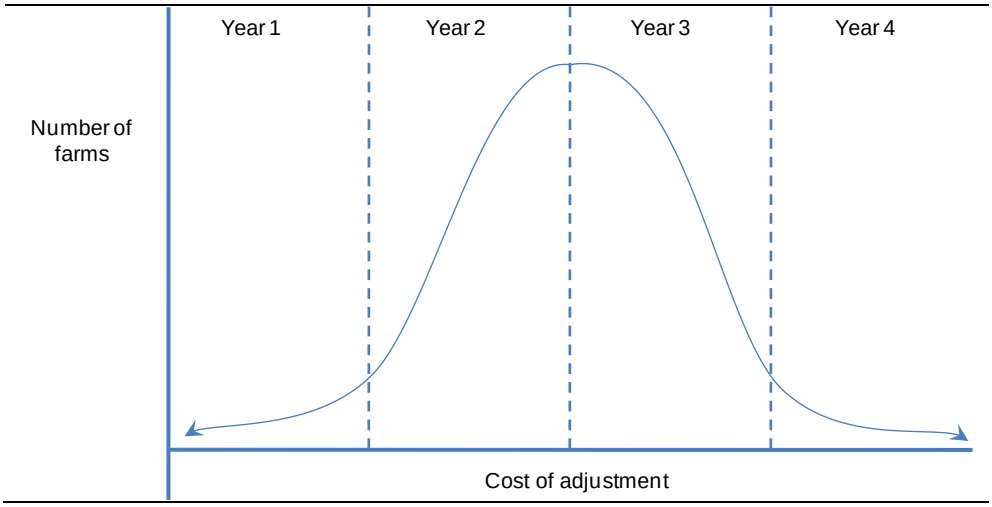
The aim of introducing a transferrable quota system is to:

- allow those farmers most affected by the cessation of the trade to defer the majority of the costs of adjustment for as long as possible
- use some of the efficiency gains of the quota system to offset some of the adjustment costs.

This reduces the overall costs of adjustment and redistributes them. The effect of a transferrable quota is represented in the stylised chart below. In year one, the producers with the least dependence on the live export trade will trade (either by way of not bidding at auction or directly selling their entitlements) their entitlement to the market with those with the most to lose. Each year the entitlements will be transferred between those on the left of the distribution curve and those on the right.

In the absence of any data on the shape of the curve, it is difficult to calculate the effect of a transferrable quota system on the costs of adjustment.

Figure 1 **Stylised representation of distribution of adjustment costs per farm and what year adjustment costs are likely to be incurred for each segment of the curve when transferrable quotas are used**



12 Sensitivity analysis

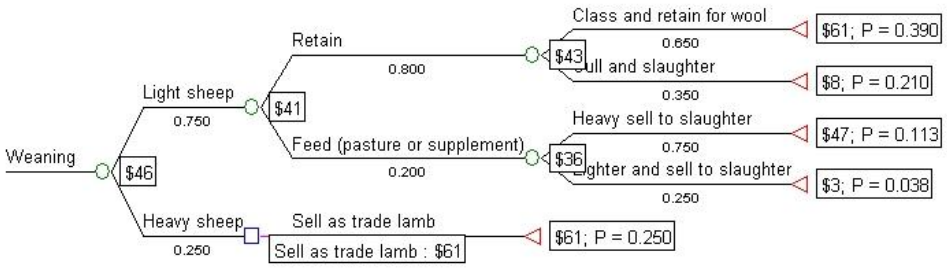
The key sensitivities of the adjustment costs are likely to be the:

- change in value of the sheep that would have been sold for live export that will be sold to alternative markets
- the additional costs associated with fattening stock earlier to meet higher value markets
- the risk of not being able to meet the specification of higher value markets (that is, fewer sheep will be sold to higher value markets and will be diverted to mutton markets)

Section 7 of this report dealing with the market effects (demand effects) of a cessation of the live export trade, concluded that if the trade were phased-out there would be minimal changes to lamb and mutton prices in Australia. This assumption underpins the NPV calculations used in section 8.

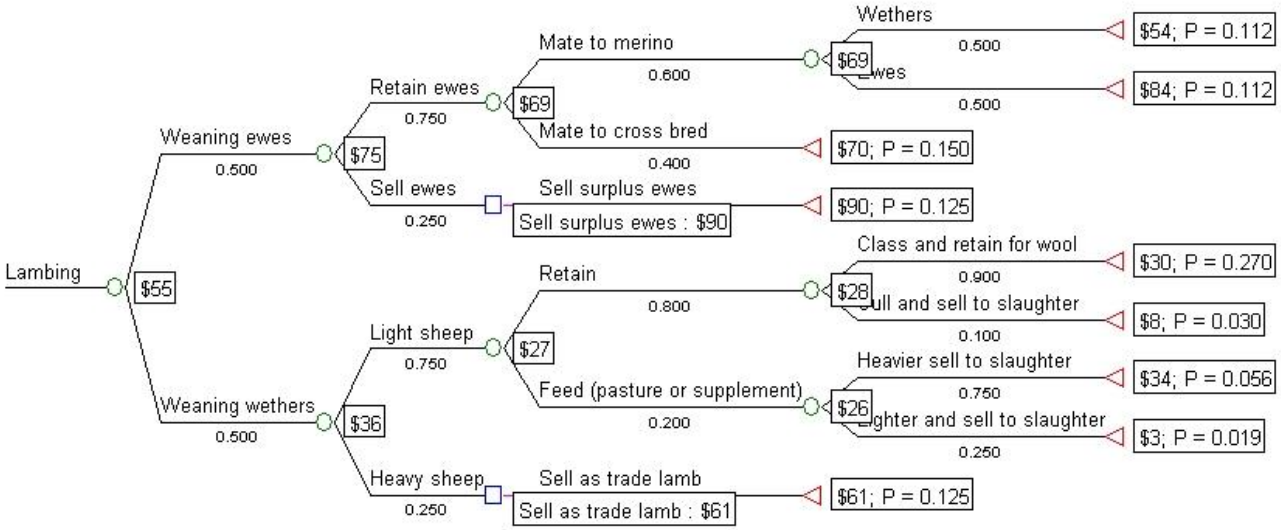
If this assumption is incorrect and the market for mutton halves, the change is in the value of the wether increase - from $2.00 to $6.00 (12 per cent decline in value)

Chart 18 **Wether enterprise decision tree with no live export sales option (assuming a halving of mutton values)**



However, while the effect of a sharp decline in mutton value is evident in the wether enterprise (Chart 1) the decline is minimal in the ewe flock as the effect is diluted by the other enterprise options (see Chart 19).

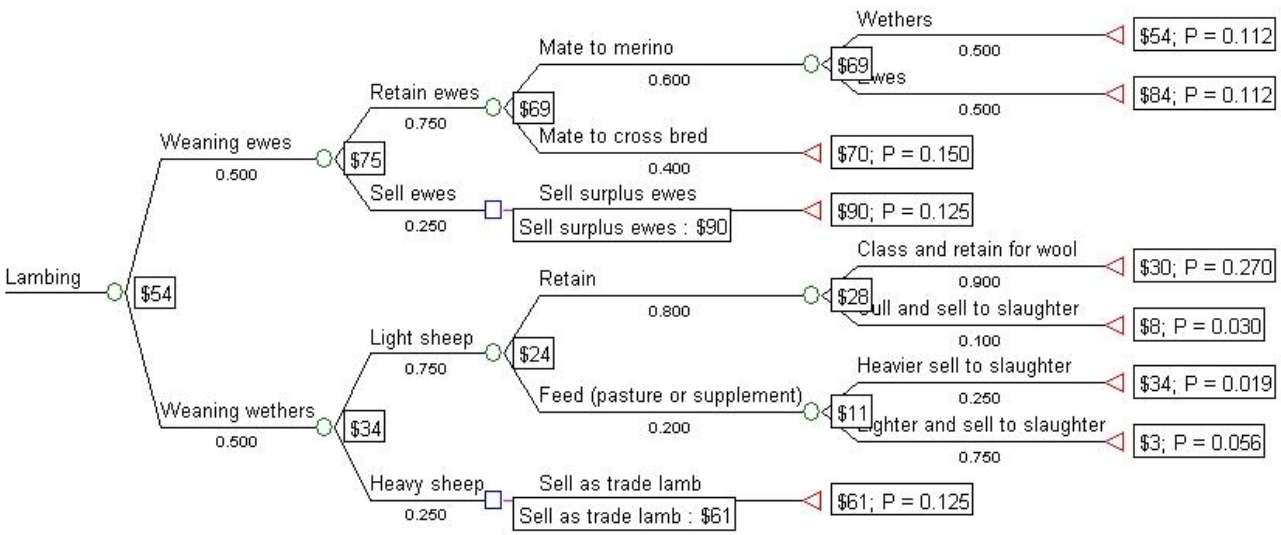
Chart 19 **Merino and cross bred mating options with no live export market (assuming a halving of the mutton values)**



As would be expected, the effects of losing the option of exporting to the live sheep market are greatest when alternative market options are low.

The difference between Chart 19 and Chart 20 is a reversal in the number of sheep sold heavy and light after the costs of preferential or supplementary feeding have been incurred.

Chart 20 **Merino and cross-bred mating options with no live export market (assuming a halving of the mutton values)**



Even when the risk of not meeting heavier weight specifications increases, the effects of a low mutton price resulting from a cessation of the live export trade appears to be significantly diluted in the ewe dominant flock enterprise. The calculations in Chart 20 show that when the proportion of wethers sold as heavy and light is reversed (from 0.75/0.25 to 0.25/0.75), the net present value of the ewe ($55) falls by a further $1.00 (1.72 per cent).

13 Conclusion

There is value for sheep enterprises in WA in retaining access to the live export market. The value of this option is dependent on the range of alternative uses of the resources used to produce the live sheep for export on each farm. The value of the live export market option will increase as alternative market options decrease.

The value of access to the live export market per farm is capped by the number of sheep that can be produced for this market, as a proportion of the total sheep numbers on the farm. On average, live sheep sales make up approximately 42 per cent of total sheep dispersals per farm in Western Australia. They are capped at 60 per cent if all male sheep are sold into this market and ewe numbers remain constant.

However, while the number of sheep sold to the live export market is large compared to total sheep dispersal, on mixed farms in WA, the proportion of sheep sales to total farm receipts ranges from 3 to 7 per cent and appears to be

declining in line with the decline of sheep numbers per farm. The structural adjustment occurring on WA farms may be propping up the number of sheep sold for live export, and, at the same time, overwhelms the effects of a cessation of the live export trade at the farm level.

Overall, the cessation of the live sheep export trade would have a modest impact on sheep net present values, even if a large drop in mutton values occurs.

Phasing-out the live export trade, coupled with a transferrable quota system, would significantly reduce the adjustment costs that would be borne by WA farmers. This would redistribute the adjustment costs to those who benefit the most from the trade, and defer those costs for the longest possible time.

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A Real options

The term "real options" refers to the application of option theory (initially developed for financial markets) to "real investments", which involve uncertainty and flexibility. Options analysis (for both financial and real options) emerged out of the desire for better ways of managing downside risk, while retaining access to upside opportunities, and of providing a sound basis for the valuation of opportunities.

As the name suggests, a real option entails the right to undertake an action – such as to invest in, or abandon, an investment – but without any obligation to do so. Importantly, real options analysis recognises the reality that managers can, and do, adapt to technological or market changes and that the scope for doing this is important to the value of a project.

Real options existed – and were being valued – long before the term was coined. However, over the past 10-15 years there has been a strong trend towards recasting the basis for assessment of projects, especially projects with substantial up-front risks and uncertainties –common features of almost every significant farm management decision. This has seen the development of a new range of methodologies that have been combined with more traditional tools for risk-based decision support.

Probably more importantly, we are seeing a fundamental shift in the approach taken to planning for investments with high levels of uncertainty – with modelling and management of risk being made central to the investment model, rather than peripherally included in sensitivity analyses. This is particularly so if climate variability increases with the rate of climate change.

Real options methods will often lead to higher project valuations than traditional deterministic approaches, such as NPV. This is because they recognise that risks can be managed to avoid bad outcomes or to take advantage of good outcomes, for example by expanding, abandoning or delaying a project. In other words, the option analysis values the strategic options – the flexibility – available to a firm that will influence its value to shareholders.

Also important is the ability of real options analysis to enable the overall value of the project to be increased. Identifying irreversible costs can enable management to design the project in ways that maximise the benefits of flexibility, and that improve the information available, before needing to decide on a commitment to those large irreversible costs.

The distortions that result from traditional deterministic NPV valuation methods, tend to be most acute when uncertainties are greatest and when there is the greatest scope for adaptive decision-making – common characteristics of decisions made during the onset of drought.

While there are a number of sophistications that can be applied to real options methodology, such as Black-Scholes valuations (see for example Amram and Kulatilaka, 2000) and Monte Carlo simulations, many of the benefits of real options analysis can often be derived, relatively simply, through the intelligent application of decision tree tools. In other cases, especially where key contributors to risks involve almost continuous change in key variables – such as market values of wethers, the price of wool or seasonal conditions – real options analysis offers an expanded set of tools well suited to the planning and valuation task.

Modern real options theory, as applied to most investments, should be viewed as a powerful combination of a set of valuation tools and a way of looking at investments. It is a way to maximise value derived over time, and to manage risk sensibly and in a way that builds value, despite high levels of uncertainty.

A.1 Simple example of real options approach

Table 14 provides a simple numerical example that illustrates some key aspects of real options analysis. It considers the simple investment of purchasing, or continuing to own, a fine wool wether, which costs $35 to undertake. That is the cost of the wether, either to purchase or the sale price forgone if retained.

Uncertainty is introduced into this example by assuming that in period 1 the wool revenue per head might rise to provide revenues of $35 per annum, or equally it might fall to $25 per annum.

Under a traditional NPV calculation, the expected value would be calculated, and discounted along with the costs to determine the expected NPV. At a discount rate of 10%, the NPV is $23.59. This is shown in Part B of the table.

Part C shows the value attached to the option of waiting for one period before investing in the wether, to determine if wool prices rise or fall. If the price rises, the investment will be undertaken in period 1, in which case revenues will be $35 pa and the costs are as before. If prices do not rise, the investment will not be undertaken and there is no cost associated with this decision.

If prices do rise the wether would be purchased. This gives an expected NPV of $29.37, so that the option of waiting one period and then undertaking the investment, is worth the difference between the NPV of investing in year one and waiting a year for the prices to rise. In this instance the value of the option is $5.77, which is only of marginal value.

Table 14 **Wether decision with small wool price variation**

	Period		0	1	2	3	4	5	Prob
A	**Assumptions**								
	Possible revenues								
	High			35	35	35	35	35	0.5
	Low			25	25	25	25	25	0.5
	Costs			17	17	17	17	17	
	Purchase of wether		35						
	Carcase value							15	
	Discount rate		10%						
B	**Expected cash flow based on probabilities of revenues**								
	Expected revenue			30	30	30	30	45	
	Expected costs		35	17	17	17	17	17	
	Net cash flows		-35	13	13	13	13	28	
	NPV	**$ 23.59**	-35	11.82	10.74	9.77	8.88	17.39	
C	**Cash flow: wait for revenues to go up**								
	Expected revenue				35	35	35	50	
	Expected costs				17	17	17	17	
	Net cash flows			-35	18	18	18	33	
	NPV	**$ 29.37**	0	-31.82	14.88	13.52	12.29	20.49	

Source: ACIL Tasman

In the example cited above, the value of waiting a year until there is more certainty about the wool price is of limited value, as the volatility is relatively small. However, when the volatility of wool prices increases, the value of this option rises.

The value of the option to wait a year before buying the wether when the price prospects for wool are more uncertain, is shown in Table 15. In this scenario, the value of wool when the investment is being considered is low enough to make the investment produce a negative NPV of $4.84. If the decision to buy the wethers is delayed by a year and wool prices rise, the NPV rises to $14.96. Thus the value of the option to delay a year is the difference between -$4.84 and $14.96, which equals $19.90.

If wool prices do not rise, the farmer does not have to exercise the option and does not buy the wethers.

Indeed, if these were the only uncertainties, then the analysis suggests a value for this option – the maximum 'option fee' that it would be worth paying to secure the rights – of about $19.90. The simple calculation provides a basis for valuing this option.

Table 15 **Wether decision with large wool price variation**

	Period		0	1	2	3	4	5	Prob
A	**Assumptions**								
	Possible revenues								
	High			30	30	30	30	30	0.5
	Low			15	15	15	15	15	0.5
	Costs			17	17	17	17	17	
	Purchase of wether		35						
	Carcase value							15	
	Discount rate		10%						
B	**Cash flow**								
	Expected revenue			22.5	22.5	22.5	22.5	37.5	
	Expected costs		35	17	17	17	17	17	
	Net cash flows		-35	5.5	5.5	5.5	5.5	20.5	
	NPV	-$ 4.84	-35	5.00	4.55	4.13	3.76	12.73	
C	**Cashflow: wait for revenues to go up**								
	Expected revenue				30	30	30	45	
	Expected costs				17	17	17	17	
	Net cash flows			-35	13	13	13	28	
	NPV	$14.96	0	-31.82	10.74	9.77	8.88	17.39	

Source: ACIL Tasman

This analysis also applies to the farmer who is considering selling the wether. If wool prices do rise it may become more valuable.

Note, however, that the decision to wait entails sacrificing the option of accessing the certain year 0 revenues of $11.82 in their own right, with the potential to help defray the capital costs of buying the wether. Recognising this, and the fact that there is a 50 per cent chance that the wether would be purchased, suggests that yet another option might reasonably be considered – that of proceeding to buy the wether in year 0, but retaining the option to then sell it in year 1 if the wool price does not increase at the end of this period. If these calculations are worked through, we derive an expected NPV of -$2.52[1].

Often the option of discovering additional information is not costless. In the above example, the cost of learning the Year 1 price before committing to the purchase, was a loss of net production revenues of $11.82. More generally, options theory has been used extensively in the analysis of oil and gas exploration, where there is uncertainty about the quantity of oil in the field, in addition to the future price. In this case, additional information can be obtained by delaying full development of the field and undertaking exploratory drilling to discover its likely size. The cost of exploratory drilling can be

[1] Assuming the wether is worth $25.00 at the end of year one.

compared to the option value of the additional information in deciding whether to undertake the full investment.

This highlights an important aspect of real options analysis, namely the ability of management to use the insights gained to improve the value of the project. In this very simple example, the source of uncertainty was clear, and the action needed to gain additional information (i.e. wait one period) was also very clear. However, in real-world examples, the source of inflexibility and the means of reducing the impact of irreversible costs are often far from obvious. Therefore options analysis can be used to add value to a project through a clear understanding of the uncertainties involved and the strategic options open to management. It can offer a powerful tool for assessing whether the incremental costs of deeper probing are likely to be cost-justifiable.

B Net present value calculation for various sheep decisions

The following spread-sheets are the net present value calculations used as the terminal nodes in the real options calculations and decision trees. They are based on the monthly income and expenses for a range of scenarios. Net present value calculations calculate the present value of a series of cash flows, to allow comparisons between investments. These calculations have used a 10 per cent weighted average cost of capital (WACC) to calculate the present value.

A weighted average cost of capital is based on a farm with 80 per cent equity, where a return of 11 per cent per annum is required and the cost of debt is 6 per cent per annum.

Each spreadsheet lays out the monthly income and expenses for each sheep investment scenario. They include all of the direct inputs, such as drench, fly control, shearing and crutching. Each scenario also includes an allocation of pasture maintenance costs and direct enterprise labour. They do not include allocations for overheads such as general labour, administration costs, interest or tax.

Table 16 **Wethers of sufficient condition score at an early age that can be sold to the domestic lamb market**

				Month	
Heavy and sell				0	5
Stock value at start of period				$15.00	
Stocking Rate				9.00	DSE / ha
DSE Value					1.3
Expenses					
Vaccination					$0.30
Drench	1	$0.40			$0.40
	2				$0.00
Jetting					$0.00
Shearing					$0.00
Crutching					$0.00
Weed Control	$5.00	ha			$0.30
Phosphorous	0.6	kg/hd/year			$1.13
	$500.00	tonne / spread			
Supplementary feed					
Total					$2.13
Deaths	2%				$2.17
Labour					
Labour efficiency		7000	/ labour unit		
Wages		$30,000.00			
On costs	22%	$6,600.00			
Vehicle		$5,000.00			
Total		$41,600.00			
Cost DSE		$5.94			$3.22
Overhead Expenses					$0.00
Total Expenses				$15.00	$5.39
Income					
Wool	kg	Greasy			
	Micron				19.0
	Yield				0.69
	kg	Clean			0.00
	cents/kg	Clean			1000
	Wool income				$0.00
			kg	cents /kg	
	Carcass Value		20.00	$4.00	$80.00
	Skin				$5.00
	Total Income				$85.00
	Cash-flow			-$15.00	$79.61
		WACC			
Per head	NPV	10.00%	$61.38	-$15.00	$76.38

Data source: ACIL Tasman

Table 17 **The second draft of wethers sold to the domestic lamb market**

				Month		
Heavy seconds				0	5	9
Stock value at start of period				$15.00		
Stocking Rate				9.00	DSE / ha	DSE / ha
DSE Value					1.1	1.2
Expenses						
Vaccination					$0.30	$-
Drench	1	$0.40			$0.40	$-
	2	$0.40			$0.40	$-
Jetting					$-	$-
Shearing					$-	$-
Crutching					$-	$-
Weed Control	$5.00	ha			$0.25	$0.22
Phosphorous	0.6	kg/hd/year			$1.13	$0.90
	$500.00	tonne / spread				
Supplementary feed						
Total					$2.48	$1.12
Deaths	2%				$2.53	$1.12
Labour						
Labour efficiency		7000	/ labour unit			
Wages		$30,000				
On costs	22%	$6,600				
Vehicle		$5,000				
Total		$41,600				
Cost DSE		$5.94			$2.72	$2.38
Overhead Expenses		$63.00			$-	$-
Total Expenses				$15.00	$5.25	$3.50
Income						
Wool	kg	Greasy				
	Micron				19.0	19.0
	Yield				0.69	0.69
	kg	Clean			0.00	0.00
	cents/kg	Clean			1000	1000
	Wool income				$-	$-
			kg	cents/kg		
	Carcass Value		22.00	$3.00		$66.00
	Skin					$10.00
	Total Income					$76.00
	Cash-flow			-$15.00	-$5.25	$72.50
		WACC				
Per head	NPV	10.00%	$47.24	-$15.00	-$5.04	$67.28

Data source: ACIL Tasman

Table 18 **Wethers that are heavy but do not make a lamb specification without additional feeding or preferential treatment and then sold to the live export trade**

				Month		
Heavy seconds sold to boat				0	5	9
Stock value at start of period				$5.00		
Stocking Rate				9.00	DSE / ha	DSE / ha
DSE Value					1.1	1.2
Expenses						
Vaccination					$0.30	$-
Drench	1	$0.40			$0.40	$-
	2	$0.40			$0.40	$-
Jetting					$-	$-
Shearing					$-	$-
Crutching					$-	$-
Weed Control	$5.00	ha			$0.25	$0.22
Phosphorous	0.6	kg/hd/year			$1.13	$0.90
	$500.00	tonne / spread				
Supplementary feed						
Total					$2.48	$1.12
Deaths	2%				$2.53	$1.12
Labour						
Labour efficiency		7000	/ labour unit			
Wages		$30,000				
On costs	22%	$6,600				
Vehicle		$5,000				
Total		$41,600				
Cost DSE		$5.94			$2.72	$2.38
Overhead Expenses		$63.00			$-	$-
Total Expenses				$5.00	$5.25	$3.50
Income						
Wool	kg	Greasy				
	Micron				19.0	19.0
	Yield				0.69	0.69
	kg	Clean			0.00	0.00
	cents/kg	Clean			1000	1000
	Wool income				$-	$-
			kg	cents /kg		
	Carcass Value		23.00	$2.20		$50.60
	Skin					
	Total Income					$50.60
	Cash-flow			-$5.00	-$5.25	$47.10
		WACC				
Per head	NPV	10.00%	$33.67	-$5.00	-$5.04	$43.71

Data source: ACIL Tasman

Table 19 **Wethers that are heavy but do not make a lamb specification without additional feeding or preferential treatment and then sold to slaughter**

				Month		
Heavy seconds sold to slaughter				0	5	9
Stock value at start of period				$5.00		
Stocking Rate				9.00	DSE / ha	DSE / ha
DSE Value					1.1	1.2
Expenses						
Vaccination					$0.30	$-
Drench	1	$0.40			$0.40	$-
	2	$0.40			$0.40	$-
Jetting					$-	$-
Shearing					$-	$-
Crutching					$-	$-
Weed Control	$5.00	ha			$0.25	$0.22
Phosphorous	0.6	kg/hd/year			$1.13	$0.90
	$500.00	tonne / spread				
Supplementary feed						
Total					$2.48	$1.12
Deaths	2%				$2.53	$1.12
Labour						
Labour efficiency		7000	/ labour unit			
Wages		$30,000				
On costs	22%	$6,600				
Vehicle		$5,000				
Total		$41,600				
Cost DSE		$5.94			$2.72	$2.38
Overhead Expenses		$63.00			$-	$-
Total Expenses				$5.00	$5.25	$3.50
Income						
Wool	kg	Greasy				
	Micron				19.0	19.0
	Yield				0.69	0.69
	kg	Clean			0.00	0.00
	cents/kg	Clean			1000	1000
	Wool income				$-	$-
			kg	cents /kg		
	Carcass Value		20.00	$1.80		$36.00
	Skin					
	Total Income					$36.00
	Cash-flow			-$5.00	-$5.25	$32.50
		WACC				
Per head	NPV	10.00%	$20.12	-$5.00	-$5.04	$30.16

Data source: ACIL Tasman

Table 20 **Wethers that are kept, classed, culled and sold to the export live trade**

				Month			
Class cull and sell to boat				0	5	9	13
Stock value at start of period				$15.00			
Stocking Rate				9.00	DSE / ha	DSE / ha	DSE / ha
DSE Value					1.1	1.2	1.2
Expenses							
Vaccination					$0.30	$0.00	$0.00
Drench	1	$0.40			$0.40	$0.00	$0.00
	2	$0.40			$0.40	$0.00	$0.00
Jetting					$0.00	$0.00	$0.00
Shearing		$4.99			$0.00	$0.00	$4.99
Crutching		$1.10			$0.00	$0.00	$1.10
Weed Control	$5.00	ha			$0.25	$0.22	$0.22
Phosphorous	0.6	kg/hd/year			$1.13	$0.90	$0.90
	$500.00	tonne / spread					
Total					$2.48	$1.12	$7.21
Deaths	2%				$2.53	$1.12	$7.21
Labour							
Labour efficiency		$7,000.00	/ labour unit				
Wages		$30,000.00					
On costs	22%	$6,600.00					
Vehicle		$5,000.00					
Total		$41,600.00					
Cost DSE		$5.94			$2.72	$2.38	$2.38
Overhead Expenses		$63.00			$0.00	$0.00	$0.00
Total Expenses				$15.00	$5.25	$3.50	$9.59
Income							
Wool	kg	Greasy					5.00
	Micron				18.0	18.0	19.5
	Yield				0.69	0.69	0.69
	kg	Clean			0.00	0.00	3.45
	cents/kg	Clean			1233	1233	911
	Wool income				$0.00	$0.00	$28.57
			kg	cents /kg			
	Carcass Value				$0.00	$0.00	$50.00
	Skin						
	Total Income				$0.00	$0.00	$78.57
	Cash-flow			-$15.00	-$5.25	-$3.50	$68.98
		WACC					
Per head	NPV	10.00%	$38.64	-$15.00	-$5.04	-$3.25	$61.93

Data source: ACIL Tasman

Table 21 **Wethers that are kept and later classed culled and sold for slaughter**

				Month			
Class cull slaughter				0	5	9	13
Stock value at start of period				$15.00			
Stocking Rate				9.00	DSE / ha	DSE / ha	DSE / ha
DSE Value					1.1	1.2	1.2
Expenses							
Vaccination					$0.30	$0.00	$0.00
Drench	1	$0.40			$0.40	$0.00	$0.00
	2	$0.40			$0.40	$0.00	$0.00
Jetting					$0.00	$0.00	$0.00
Shearing		$4.99			$0.00	$0.00	$4.99
Crutching		$1.10			$0.00	$0.00	$1.10
Weed Control	$5.00	ha			$0.25	$0.22	$0.22
Phosphorous	0.6	kg/hd/year			$1.13	$0.90	$0.90
	$500.00	tonne / spread					
Total					$2.48	$1.12	$7.21
Deaths	2%				$2.53	$1.12	$7.21
Labour							
Labour efficiency		7000	/ labour unit				
Wages		$30,000.00					
On costs	22%	$6,600.00					
Vehicle		$5,000.00					
Total		$41,600.00					
Cost DSE		$5.94			$2.72	$2.38	$2.38
Overhead Expenses		$63.00			$0.00	$0.00	$0.00
Total Expenses				$15.00	$5.25	$3.50	$9.59
Income							
Wool	kg	Greasy					5.00
	Micron				18.0	18.0	19.5
	Yield				0.69	0.69	0.69
	kg	Clean			0.00	0.00	3.45
	cents/kg	Clean			1233	1233	911
	Wool income				$0.00	$0.00	$28.57
			kg	cents /kg			
	Carcass Value		22.00	$1.40	$0.00	$0.00	$30.80
	Skin						
	Total Income				$0.00	$0.00	$59.37
	Cash-flow			-$13.60	-$5.25	-$3.50	$49.78
		WACC					
Per head	NPV	10.00%	$22.80	-$13.60	-$5.04	-$3.25	$44.69

Data source: ACIL Tasman

Table 22 **Wethers that will be retained**

				Month					
Retain				0	12	24	36	48	60
Stock value at start of period				$15.00					
Stocking Rate				$9.00	DSE / ha				
DSE Value					0.9	1.0	1.1	1.1	1.1
Expenses									
Vaccination					$0.30	$0.30	$0.30	$0.30	$0.30
Drench	1	$0.40			$0.40	$0.40	$0.40	$0.40	$0.40
	2	$0.40			$0.40	$0.40	$0.40	$0.40	$0.40
Jetting					$0.00	$0.00	$0.00	$0.00	$0.00
Shearing		$4.90			$4.90	$4.90	$4.90	$4.90	$4.90
Crutching		$1.10			$0.00	$0.00	$0.00	$0.00	$0.00
Weed Control	$5.00	ha			$0.50	$0.56	$0.61	$0.61	$0.61
Phosphorous	0.6	kg/hd/year			$2.70	$2.70	$2.70	$2.70	$2.70
	$500.00	t/ spread							
Total					$9.20	$9.26	$9.31	$9.31	$9.31
Deaths	2%				$9.39	$9.39	$9.39	$9.39	$9.39
Labour									
Labour efficiency		7000	/ labour unit						
Wages		$30,000.00							
On costs	22%	$6,600.00							
Vehicle		$5,000.00							
Total		$41,600.00							
Cost DSE		$5.94			$5.35	$5.94	$6.54	$6.54	$6.54
Overhead Expenses		$63.00			$0.00	$0.00	$0.00	$0.00	$0.00
Total Expenses				$15.00	$14.74	$15.33	$15.92	$15.92	$15.92
Income									
Wool	kg	Greasy			3.50	4.70	5.20	5.20	5.20
	Micron				18.0	18.5	19.2	19.2	19.5
	Yield				0.69	0.69	0.69	0.69	0.69
	kg	Clean			2.42	3.24	3.59	3.59	3.59
	cents/kg	Clean			1233	1116	964	964	911
	Wool income				$29.78	$36.19	$34.59	$34.59	$32.69
	Value								$15.00
	Income				$29.78	$36.19	$34.59	$34.59	$47.69
	Cash-flow			-$15.00	$15.04	$20.86	$18.66	$18.66	$31.76
		WACC							
Per head	NPV	10.00%	**$61.39**	-$15.00	$13.61	$17.09	$13.84	$12.53	$19.30

Data source: ACIL Tasman

Table 23 **Ewe net present value calculation**

	Month			0	1	2	3	4	5
Stock value at start of period				$25.00					
DSE Value					1.5	1.5	1.5	1.5	1.5
Expenses									
Vaccination					0.3	0.3	0.3	0.3	0.3
Ram costs		$1,000.00	/Ram						
Ram amortized over 4 years		7.60%	$299.24						
Death Rate		4%	$311.71						
Ram Working Life		4.00	years						
Ram Mating %		1.10%			$4.68	$4.68	$4.68	$4.68	$4.68
Marking					$1.00	$1.00	$1.00	$1.00	$1.00
Drench	1	$0.35			$0.35	$0.35	$0.35	$0.35	$0.35
	2	$0.35			$0.35	$0.35	$0.35	$0.35	$0.35
Shearing		$3.25			$3.25	$3.25	$3.25	$3.25	$3.25
Crutching					$0.80	$0.80	$0.80	$0.80	$0.80
Weed Control	$15.00	ha			$1.61	$1.61	$1.61	$1.61	$1.61
Phosphorous	0.7	kg/hd/year	$212.00	tonne	$1.34	$1.34	$1.34	$1.34	$1.34
Total					$13.67	$13.67	$13.67	$13.67	$13.67
Deaths	2%				$13.95	$13.95	$13.95	$13.95	$13.95
Labour									
Labour efficiency		10000	/ labour unit						
Wages		$28,000							
On costs	14%	$3,920							
Vehicle		$10,000							
Total		$41,920							
Cost DSE		$4.19			$6.29	$6.29	$6.29	$6.29	$6.29
Overheads			ha		$-	$-	$-	$-	$-
Total Expenses				$25.00	$20.24	$20.24	$20.24	$20.24	$20.24
Income									
Wool	kg	Greasy			4.50	5.25	5.25	5.25	5.50
	Micron				18.5	19.0	19.0	19.0	19.5
	Yield				0.69	0.69	0.69	0.69	0.69
	kg	Clean			3.11	3.62	3.62	3.62	3.80
	cents/kg	Clean			1116	1000	1000	1000	911
	Wool income				$34.65	$36.23	$36.23	$36.23	$34.57
	Carcass Value								$30.00
	Lamb value				$30.00	$35.00	$35.00	$35.00	$35.00
Lamb Weaning %			95%		$28.50	$33.25	$33.25	$33.25	$33.25
	Total Income				$63.15	$36.23	$36.23	$36.23	$64.57
	Cashflow			-$25.00	$42.92	$15.99	$15.99	$15.99	$44.34
Per head	NPV	7.60%	$84.20	-$25.00	$39.89	$13.81	$12.84	$11.93	$30.74

Data source: ACIL Tasman