

WA Government Submission

Live Sheep Export Phase-Out

Executive summary

There is a significant risk to Western Australia's farming systems from the transition out of the live export of sheep, particularly if the transition does not allow sufficient time or resources. In the absence of increased support to the processing capacity and development of export markets for meat and wool, the size of WA sheep flock may drastically reduce as farmers switch from mixed-enterprise systems to solely broadacre cropping. This will also have a devastating impact on the broader WA merino wool industry.

On modelling of only a 15 per cent drop in the size of the WA sheep flock as a result of the ending of live exports, the cost to the agricultural industry without a reallocation of land asset to cereal cropping would be in the order of \$123 million annually. With a redeployment of land asset to cereal grains as a replacement, the cost would be in the order of \$22 million annually. This modelling also shows an overall reduction of potentially 387 jobs across the supply chain, which would have a negative flow on impacts across WA regional communities.

Livestock play an important role in sustainability within WA broadacre farming systems. Rotational grazing systems and permanent pastures improve soil health and fertility by increasing soil microbial density, nutrient availability, and organic matter due to the addition of manure and grazing animal movement. In turn, this increases carbon sequestration and reduces the need for fertiliser inputs.

Taking livestock out of the farming system entirely will result in risks to farming businesses, the environment, rural community structures and regional and state economies. Any phase out of live export needs to be managed well, with resources provided to support the processing sector, market development and the ability for the WA sheep industry to diversify its farming operations.

Significant transitional support for the Western Australian industry, and a long transition period, is required to ensure that the potential risks from the cessation of live export are minimised and WA farming systems remain diversified and sustainable.

1. Background

In March 2023, the Federal Government confirmed it would phase out live sheep exports by sea during the next term of government. This decision comes after previous reviews and decisions to amend regulations for the export of live sheep to the Middle East to avoid heat stress during the northern hemisphere summer.

There has been a long-term decline in live sheep exports, which has been exacerbated in recent years by the overall decline in the Australian sheep flock, increase in the importance

of meat vs wool, improvements in eating quality of lamb and introduction of the moratorium on live exports during the northern hemisphere summer.

Western Australia's (WA) exports have declined from nearly 2 million live sheep in 2014 to 0.52 million in 2022, with WA now supplying 99% of Australia's sheep exported live. However, the live sheep export market still plays an important market option for many sheep producers in WA, to reduce risk in their business or turn-off sheep quickly in poor seasons and creates a floor price for market competition.

This paper summarises the key outcomes from research conducted by the Department of Primary Industries and Regional Development (DPIRD) since the announcement by the Federal Government. This paper does not include commentary on the numerous other reports that have been prepared previously or recently by other companies.

2. Current industry situation and sentiment

There are several factors have contributed to the current difficult trading situation for the WA sheep industry in the first half of 2023.

- An over supply of sheep in the market due to the back log of getting sheep processed.
- Processors have not fully recovered from the impact that the COVID pandemic had on the availability of skilled labour.
- A later start to the growing season in 2023 compared to the previous two years, meaning less food on offer and some farmers having stock on hand that would normally have been sold to make way for cropping program.
- On-going issues with on-farm labour, access to shearers and general rising costs.
- Limited demand for sheep from the eastern states and a decline in national prices in the six months to July 2023.
- The size of the WA flock declined from 14.5M in 2017/18 to 12.4M in July 2022, due in part to high interstate transfers in 19/20 and 20/21.

Other major changes have seen an increase in the importance of processing of lambs (30% in 2010/11 vs 57% in 2021/22), and an improvement in marking rates (84 to 96% for Merinos from 2011 to 2022). These are indications of improved management, most likely amongst those farmers who view sheep as an important component of a mixed farming system. While there are strong market signals for the wool industry, the availability of shearers is a major issue for some producers.

A measure of industry sentiment can be taken from an updated survey conducted by MLA & AWI (1) between 27 April and 23 May 2023. Of the 1,958 producers surveyed nationally, 405 were from WA. The three most significant pressures listed by producers were costs, workforce, and regulation. A measure of sentiment (% positive - % negative) was completed and compared with that recorded in October 2022. Nationally, sentiment in the wool industry was +13 which was up 1 point on the October survey. For non-WA producers it measured +15 and for WA producers it measured +1. The sheepmeat industry measured +27 which was down 40 points compared to October 2022. This was driven by WA producers with a rating of -48 compared to +37 for non-WA producers, meaning more producers in WA felt negatively about the future of the sector compared to other states for the reasons listed above. Over the next 12 months, the WA producers forecast was:

- 18% fall in the breeding flock (vs 6% decline nationally).
- 33% fall in the wether flock (vs 14% decline nationally).
- 46% of WA producers were expecting to have less breeding ewes on hand in April 2024 than now, versus 32% for national predictions.

In summary, the WA sheep industry was already facing several challenges prior to the announcement by the Federal Government, which have all combined to produce a negative sentiment in the industry. The dominance of the grains industry in WA does provide many producers with an alternative option to sheep that is often more profitable per hectare but is not without risk. There are also many producers, who are very confident in the future of the industry and continue to invest in infrastructure and new management to improve their profitability. An example of this is the increased interest in the development of intensive feedlot facilities for sheep, many of which are producers (DPIRD, unpublished).

3. Market opportunities

In 2022, 81% of sheep disposals in WA were processed locally, with 82% of that exported to 44 different countries (2). Assuming that there will be no major change in domestic consumption of sheepmeat or change in demand from the Eastern States, then any additional sheep or lambs that would otherwise have been exported live will need to be processed locally and then exported. Therefore, global demand for sheepmeat, and the capacity of WA processors to capitalize on the opportunities to grow export markets and provide strong market signals to WA producers, will be important for the future of the WA sheep industry.

Meat and Livestock Australia (MLA) has produced an update on market information in May 2023 (3), which highlights the opportunities for the sheepmeat industry:

- Global sheepmeat import demand forecast at +2.3% between 2023-2027, driven particularly by Asia and MENA.
- Global sheepmeat prices have remained firm vs other proteins (beef, pork, and poultry).
- Australia has a highly diversified range of high value global export markets for lamb and mutton.
- Despite becoming Australia's main live sheep exporting state, WA has been diversifying its exports to take advantage of global demand in growth.
- Focus markets are China, MENA, UK, US, Japan, Korea, Hong Kong, Taiwan, SEA.
- Forecast increase in national exports 2022-25: mutton 33%, lamb 8%.

4. Processing capacity

The processing sector will play a key role in the potential impact of a phase out of the live sheep export industry, as well as helping drive confidence in the industry to capture the market opportunities identified by MLA. DPIRD staff conducted interviews with the 10 largest sheepmeat processors in WA during April and May 2023 to gauge their capacity, issues, and opportunities. This survey was conducted in confidence, but overall capacity was calculated to be 471,200 per month. Sheep supply is seasonal with peak turn-off between September and December. Over the last five years (2018-2022), average monthly slaughter plus live exports exceeded slaughter capacity only in November by about 8,000/month.

Major issues reported by processors include:

- Access to a skilled and reliable workforce, plus lack of accommodation for workers.
- Timeframe for processing of worker Visas.
- Availability of sheep that meet required specifications.
- Government standards and regulations.
- Cost of business may limit expansion for some.
- Transport, in particular availability of truck drivers.
- The slow recovery of the USA supply chain recovery post-COVID when there was a delay in unloading container ships.

Opportunities the processors considered include:

- Over the past 18 month all have indicated an intention to expand operations in some form.
- Most now have contracts with businesses operating feedlots to secure supply and quality.
- Introduction of electronic identification of sheep, but this will require investment on the slaughter floor.
- Increase in automation to improve efficiencies and reduce cost of labour.
- Several investigating new export markets for chilled or frozen product.

5. Supply chain disruption

Several factors have contributed to disruption to the supply chain in the short and long term. These include:

- Shortage of air freight to the Middle East. Cost of air freight rates have returned to pre-Covid levels, the availability of freight for export is variable depending on the type of planes being used and hence capacity for freight and/or passenger luggage.
- Collapse of the national Scotts Transport Company has had flow-on impact for some processors who have relied on this trucking company to move product.
- Lack of freezer space in Perth, with some of the existing space being taken up by retailers to secure food supply in the event of any future disruption to east-west supply chains.
- Air freight lamb is a good option in theory but not if the costs are relatively high and there is not consistent availability to form the basis of a selling strategy for farmers.
- The sale of lambs or sheep to the Eastern States is an opportunistic component of the selling strategy because it relies on seasonal conditions in the east and hence irregular demand.

The issues raised by the processing sector listed above, especially the shortage of a skilled and reliable workforce, will need to be overcome for processors to operate at capacity and hence avoid the situation where lack of a market becomes a bottleneck in the supply chain, even if for only a short period.

6. Impact of a phase out of the live sheep export industry

The potential impact of a live sheep phase out on the sheep industry is difficult to predict as it is influenced by the producer's location and production system as well as the season. However, we do know that it will have a direct impact on individual producers, on the size and structure of the flock, and the overall economic value of the industry. To provide some parameters around this impact sheep enterprise modelling was undertaken.

6a Sheep Enterprise Production and marketing options

The aims of the modelling were to:

- I. Quantify the effect of cessation of live export on a merino enterprise.
- II. Quantify changes to the production system required to at least maintain enterprise profitability.
- III. If live export is not available, what is the next best-selling option with minimal changes to the production system?

Methodology:

The Australian Farm Optimisation (AFO) model is a whole farm linear model that represents the economic and biological details of a farming system including modules for rotations, crops, pastures, sheep, crop residue, supplementary feeding, machinery, labour and finance. The AFO model was selected as a suitable tool for the analysis because it has an accurate representation of whole-farm feed supply and demand throughout the entire year, along with a detailed representation of wool and meat production for different flock structures. These components of AFO have facilitated a detailed comparison of farm economics across a range of flock structures.

The model parameters used were:

- The Farm was based in the Darkan/Kojonup area as this is where many producers are strongly reliant on live export market.
- 100% Merino flock and ewes joined to Merino rams.
- July lambing and cropped area fixed at 46% of effective area.
- Winter grazed area (wgh) of 1,157ha.
- A important assumption is that the various markets are directly linked and prices move in parallel.
- Selling options used:
 1. Light weight lamb – selling as store lambs to graziers, feedlots or for processing into chilled airfreight market.
 2. Heavy weight lamb – selling finished lambs to processors;
 3. Shipper – selling into the live shipper market.
 4. Mutton – selling wethers into the mutton market.

Results:

- For farmers with average/typical management, where the focus is more on the number of sheep produced and grain production rather than ensuring the maximum number of lambs meet processor specifications, live export and light lambs are the most profitable enterprises, a situation that reflects the current broad selling strategy of most growers (gross margin of \$220/wgh) (Figure 1 – base scenario).

- The same farmer selling into the mutton market would result in an approximately 10% reduction in margin (\$200/wgh) or selling wether lambs into the heavy lamb market results in a lower profit as a result of not achieving the optimum specification for the processing grid (\$175/wgh).
- The most profitable Merino enterprise strategy is to utilize improved nutrition to quickly (likely by the age of 10-12 months) get Merino wether lambs to market specifications (weight, lean meat yield and carcass fat), and then to sell finished wethers into the processing market. This strategy requires farmers with good stock management, or with capacity to improve their stock management over a period of time.
- Wool income is also maximized under the strategy to sell heavy lambs (\$623 vs \$596/wgh for shippers).
- Relative profit margins for each scenario remain similar relative to each other for a 25% fluctuation in the price for meat or wool.

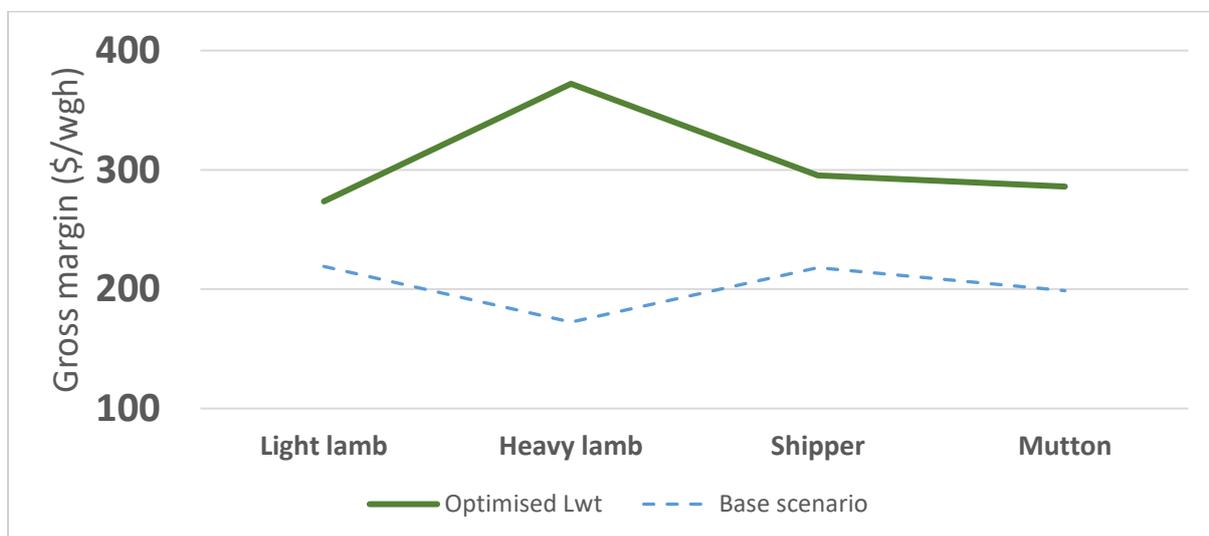


Figure 1. Enterprise gross margin (\$/winter grazed hectare) for different selling strategies under the Base scenario (typical management) compared to when management is Optimized to achieve optimal liveweight and processor specifications.

6b WA Sheep flock modelling (Pritchett)

The aim of this exercise was to predict the potential impact of a range of scenarios on the size of the WA sheep flock and on wool production over a 10-year period (4). The scenarios included:

1. Increasing the proportion of wethers in the flock at the expense of ewes. This scenario envisages that some producers may retain wethers for wool production if they found it too difficult to meet processor specifications for heavy lambs.
2. Change in the ratio of ewes joined to merino and non-merino rams (reflecting that some producers will change their focus to produce cross bred lambs)
3. Change in the percentage of farmland dedicated to sheep (depending on land type, some producers may increase cropping and reduce sheep numbers)
4. Change to the number or class of sheep transferred east (is reliant on seasonal conditions and hence demand in the eastern states, and transport costs)

Based on industry sentiment (section 2) it is unlikely that the size of the WA sheep flock will remain as at present, for a multitude of factors including the phase out of the live sheep export industry. Based on the survey data from WA producers (1) it was assumed that a 10% decrease in the WA sheep flock over the next two years was possible. It was also assumed that there would be a decrease in the percentage of ewes joined to merino rams reflecting the greater focus on cross bred lambs, from the current 64% to 55% (5).

Over a 10-year period, these changes would lead to:

- A 13% decrease in the size of the flock over the 10 years, from 12.0M to 10.5M.
- A decline in Lamb slaughter from 3.2M in year one to 2.8M in year 10
- A fall in sheep slaughter from 1.4M in year one to 1.1M in year 10.
- A decrease in wool production from 52.6M kg in year one to 43.1M kg in year 10, a decline of 18%, due to both a smaller flock and less merinos.

6c Modelling economic impact along the value chain

Understanding the impact of phasing out live export on the sheep supply chain, the effects of changes in supply and demand for sheep meat and live sheep, and the inter relationships between them, was examined through a sheep industry value chain model developed at DPIRD. This model is a subset of a much larger input-output model of the WA state's economy. It aims to identify and measure the composition and level of economic activity in the sheep supply chain from before farm gate to domestic and export markets.

The model includes some important assumptions about the way sheep farmers, and the remainder of the supply chain, are likely to act in the event of the cessation of live export by sea. The key assumption follows from that described in 2 and 6b above; that the phase out of live export industry will see a decline in the sheep flock.

The turnover or the revenues of several segments of the value chain are likely to be affected by the phase out. The value-add component of the revenue of each segment of the value chain is reported here to avoid double counting that can occur when aggregating the cumulative revenues or gross value of production. This is because the inputs of one segment are outputs of the segment that supplied the goods and services required by the firms down the value chain. The value-add, also called gross state product in the national accounts of the ABS, is a combination of company/business profits, wages and salaries, and taxes paid. The social indicator is the employment expressed as fulltime equivalents (FTEs).

The sheep value chain model was used to measure the change in turnover (revenue) across the sheep value chain, including the suppliers of inputs to farms and processors, and turnover at both the farm and processor level. It is assumed that the volume and value of meat for lamb/sheep slaughter for the domestic market remains constant.

Two scenarios were considered in comparison to the current situation to understand the impact of the cessation of live sheep exports to the WA sheep value chain:

- **Scenario A:** Current situation of 12.4M head flock size, turning off 5.1M sheep and lambs, of which 600,000 are exported live, and harvesting 53M kg of wool.

- **Scenario B:** No sheep are exported live and negative sentiments in the industry lead to a 15% drop in flock size (10.5M head) and harvesting 43M kg of wool. Impacted producers do not reallocate land previously used for sheep production to another enterprise.
- **Scenario C:** No sheep exported live leading to the same impact on the sheep and wool industry as Scenario B, however farmers change their land use on the 400,000 hectares of land that was previously grazed to grow a combination of wheat, barley, and canola (WBC).

Table 1 shows a summary of the key economic and social indicators along the full value chain. The value chain includes several firms and business entities that are likely to be impacted by the phase out of live sheep export trade, including suppliers of inputs to farms and processors, the shearing industry, stock transport, stock agents and processors.

Table 1. Summary table of economic and social impact of phase out of live sheep exports (LSE) for three scenarios.

Alternative Scenarios	\$M of three types of value-add (FTE)				Jobs Employment
	Profit	Tax	Salaries & Wages	Total	
A: Live sheep export	503	48	478	1,028	4,913
B: No LSE (15% less flock)	438	41	427	905	4,223
Comparison (B-A)	-65	-7	-51	-123	-690
C: No LSE with WBC	500	46	460	1,006	4,526
Comparison (C-A)	-3	-2	-18	-22	-387

A more detailed analysis of the value chain in the three scenarios is shown in Table 2.

A decline in WA sheep numbers of 15% would take our state flock to 10.5 million head of sheep. Across the entire value chain in WA, this would have a negative impact of \$123M, and would result in a reduction of 690 FTEs.

The decrease in on-farm value add equates to \$79M, and 447 FTEs with sheep farming alone. The total loss of \$123M is due to the combined negative impact for those businesses supplying farms (-\$37M), and abattoirs processing fewer sheep (decline from 4.0M per year to 3.9M resulting in -\$11M value add).

Scenario B represents what the economic impact of the cessation of live sheep exports would be in isolation, where producers do not restructure their business to reallocate land resources to another enterprise.

For scenario C, there is still a \$79M decrease on-farm attributed to the reduction in the sheep flock. However, as the land that was previously grazed is used for cropping in this scenario then there is a \$101M gain in on-farm value. While there is a gain of 304 FTEs attributed to increased grain production, there is still a net decrease in FTEs of 387 FTEs due

to the greater reduction associated with sheep farming, and suppliers of inputs to farms and abattoirs.

What is evident from this modelling is that where there is a decline in the WA sheep flock, there is a negative economic and social impact on the entire value chain, from suppliers of inputs to farms through to processors.

Table 2. Economic and social impact of a phase out of live sheep exports (LSE), scenario B, in which negative sentiments lead to 15% drop in the size of WA sheep flock and farmers change the use of land previously in pasture for grazing sheep to a rotation of wheat, barley and canola (WBC).

+/-	Businesses and firms	\$M value add			FTEs	
		Profit	Tax	Salaries & Wages		Total
LSE	along the sheep industry value chain					
Live Sheep Export	Suppliers of inputs to farms	144	10	109	263	1,441
	Mixed sheep & crop farms - flock size 12.4M hd	174	22	154	350	1,975
	Abattoirs process 4.0M hd for local and export	177	15	213	405	1,417
	Suppliers of inputs to abattoirs	8	1	1	10	80
	Sub total of LSE value chain	503	48	478	1,028	4,913
No Live Sheep Export	Suppliers of inputs to farms	124	9	94	226	1,240
	Farms - 10.5M hd sheep (1,900,000 fewer)	135	17	120	271	1,528
	Farms: add 400,000 ha of crop rotation: WBC	62	5	33	101	304
	Abattoirs process 3.9M hd	172	15	207	394	1,377
	Suppliers of inputs to abattoirs	8	1	6	14	77
Sub total of No LSE value chain	500	46	460	1,006	4,526	
Change attributed to No LSE	Suppliers of inputs to farms	-20	-1	-15	-37	-201
	Farms: with 1,900,000 fewer sheep	-39	-5	-35	-79	-447
	Farms: add 400,000 ha of crop rotation: WBC	62	5	33	101	304
	Abattoirs process fewer sheep	-5	-0.4	-5.9	-11	-40
	Suppliers of inputs to abattoirs	-0.3	0.0	4.9	4.6	-3
	Change (No LSE minus LSE) excluding cropping	-65	-7	-51	-123	-690
Change (No LSE minus LSE) including cropping	-3	-2	-18	-22	-387	

Conclusion

Several market factors, as well as the proposed phase out of the live sheep export market, are contributing to the negative sentiment amongst many WA sheep producers. This is despite positive signals on the demand for sheepmeat on international markets. If prices for lamb and sheep are high enough to provide profitable returns to sheep producers, through strong demand in international markets and improved capacity and efficiencies in local processing, those currently selling into the live export market may not be required to make significant changes to their enterprise to maintain similar levels of profit. For example, they may be able to sell approximately 20% more sheep earlier and/or sell a similar proportion later to fit in with processor requirements.

If the phase-out of live exports occurs before there is time for adjustments to be made in the processing sector, in particular resulting in an over-supply of sale sheep like at present, meat prices will fall and the profits of all sheep enterprises in the state will be directly reduced, not just those selling to live export.

The transition must be managed well with clear direction and sufficient time and resources for adjustment along the whole supply chain.

If the transition is not managed well everyone with sheep is likely to be affected. The current situation is a good example of what happens in an oversupply situation. Pricing has dropped significantly, and specifications have increased, so buyers are being more selective with what they are choosing, and growers are having to work harder (and spend more) to sell sheep. The sensitivity analysis shows that it is a straight-line effect on profits and changing flock structure doesn't and can't solve the problem.

Modelling indicates the greatest economic impact will be on sheep producers and those businesses directly supporting the sheep supply chain, from both an economic and employment perspective.

Significant support, resources and a long transition period are required to ensure that the potential risks from the cessation of live export are minimised and that the WA farming systems remain diversified and sustainable.

Reports

1. Sheep Producers Intentions Survey May 2023 (MLA and AWI, June 2023)
2. Sheep Notes June 2023 (Kate Pritchett)
3. Factbook of Australian live sheep and sheepmeat exports. Market information, insights and adoption, May 2023.
4. Implications of management decision on the WA sheep flock in response to changing markets – 2023 update (Kate Pritchett)
5. Flock scenario modelling update – addendum July 2023 (Kate Pritchett)

Appendix A - Key Assumptions for Value Chain Analysis

To conduct the value chain analysis, it was necessary to make some assumptions.

A.1 Demand and supply

It was assumed that prices for sheep would remain the same with and without the live sheep trade. The scenarios described here assume a 5-year equilibrium state for sheep industry with and without LSE. The prices at farm and meat processor levels were kept the same to avoid speculation. The idea of keeping the price the same for both scenarios is not unreasonable. That is because even if there are short term reductions in price (one or two seasons), due to phase out of LSE, the market can be expected to return to similar prices paid for sheep by processors. This is specially so, when we consider MLA and ABARES analysts stating that in the next 5 to 10 years there will be increased demand of just over 2% per annum from China (and other Asian countries) as well as MENA, for chilled and frozen carcasses and cuts of mutton and lamb (MLA, 2023).

A.2 Prices and costs of production

Category of sheep related commodity	LSE	No LSE
Live export	\$130 per head	-----
Value of sheep at farm gate	\$130 per head	\$130 per head
Cost of production at farm (meat and wool) No LSE has higher cost of supp. feeding to deliver to WA meat processors' specification	\$41 per head	\$63 per head
Slaughtered and processed in WA for domestic use	\$200 per head	\$200 per head
Slaughtered and processed in WA for export sales	\$225 per head	\$225 per head
Wool price at farm gate	\$8.40 kg greasy	\$8.40 kg greasy

A.3 Flock structure and wool assumptions

- Farmers who supply live sheep trade retain their self-replacing merino flock structures.
- In the No LSE scenario sheep diverted to meat processing in WA are merino lambs and wethers.

A.4 Turnoff and wool production

- Proportion of flock sold is 39% for the LSE scenario and 41% for the no LSE scenario.
- Wool yield (greasy fleece cut per adult sheep) is 4.1 kg per head in the LSE scenario and 4.3 kg per head in the No LSE scenario. This is because of the assumption of shift to supply of younger sheep to meat processors in the absence of LSE.

A.5 Farming system adjustments

- For the No LSE scenario farmers adjusting to phase out of live sheep trade are assumed to not make any changes to their cropping strategy.
- Farmers affected by phase out are assumed to maintain similar seasonal responses in allocating their land and inputs (e.g. fertilizers) to the same mix of cropping and livestock as per live sheep trade scenario.

A.6 Processing capacity

- Meat processors sell to wholesalers direct for both export and domestic markets.
- Meat processors are assumed to expand operations to accommodate additional sheep and lamb in the event of No LSE.
- Feedlots and other graziers (e.g. grow out facilities) are assumed to adjust their operations and contracts to the No LSE scenario.
- Innovations in the value chain such as digitization and automation are assumed to continue to improve efficiencies and reduce cost of labour.
- New export markets and increased demand from existing markets, such as MENA and China for chilled or frozen product are assumed to continue for foreseeable future.

A.7 Inter-state trade of live sheep

- Proportion of interstate live sheep trade (sold to eastern states of Australia) is 9% of turnoff in the LSE scenario and 5% of turnoff in the NO LSE scenario.
- Sheep sold live to interstate is assumed to be 0.46 million for LSE scenario and 0.20 million for no LSE scenario.

A.8 Value adding and employment

Other assumptions concerning economic and social indicators are shown in the table below.

Key economic and social indicators	Suppliers of inputs to farms and abattoirs	Farm	Abattoir / Processor
Profit as proportion of turnover or revenue	18.9%	12%	31.6%
Salary and wages- all staffs incl. managers/owners	14.4%	13%	24%
Net tax as % of turnover (% of profit in brackets)	1.4% (7%)	2% (17%)	2% (6%)
Employment FTEs per \$million turnover or revenue*	1.9	1.7	1.6

*: FTEs are sourced from the multipliers estimated using the Input-output Table of DPIRD, a subset of National Accounts.

Appendix B – Methodology for Value Chain Modelling

The sheep industry value chain model developed at DPIRD is a subset of the much larger input-output model of the WA state's economy. It aims to identify and measure the composition and level of economic activity in the sheep supply chain from before farm gate to domestic and export markets, understand the inter-relationships between industries associated with the sheep production system and study the effects of changes in supply and demand for sheep meat and live sheep trade throughout the economy. It is formulated on some important assumptions about the way sheep farmers and the remainder of the supply chain are likely to act in the event of the cessation of live export by sea.

Definitions of some of the economic modelling and analysis terms that will be used in this report are similar to those used by Meat & Livestock Australia (MLA, 2022) and include:

- Industry turnover: the income generated by business within the industry from the sales of goods and services. It includes the income generated from rent, leasing and hiring income.
- Industry value add: the overall value of goods and services produced by businesses in an industry (also known as contribution to gross domestic product [GDP]).

The term 'agri-industry' refers to both farm and non-farm sectors (such as manufacturing, wholesale, retail and export which are linked to the farm sector in terms of the flow of goods and services). The term 'value added' refers to the difference between the gross value of production and the value of materials and services used in production. The term gross value of agricultural production (GVAP or GVP) indicates the farming sector's contribution to the State or national income; the latter is the gross income of the farming sector.

These types of models are useful tools for economic analyses of a variety of policy issues:

- identifying and measuring the composition and level of economic activity in the supply of sheep industry from before farm gate to domestic and export markets;
- understanding the inter-relationships between industries associated with the sheep production system;
- studying the effects of changes in supply and demand for sheep meat and live sheep trade throughout the economy;
- analysing the flow of goods and services between industries and final users
- providing the basis for the calculation and measurement of revenues of each of the elements of the value chain and value adding by each of the;
- studying the potential effects of policy interventions on regional income, output and employment.

An agrifood value-chain is a complex system that creates and delivers products that consumers value. The conceptual framework of agrifood value-chain enables analysts to model the technical, marketing, economic, social and institutional dimensions of one or more sectors of agricultural industry, and integrating their results. Using the chain-based perspective helps in evaluation of industry level outcomes of alternative policies/regulations, R&D programs, and change in seasonal climatic or market variations (Collins et al., 2015).

The physical, economic and social indicators estimated by the value chain model are as described by FAO (2022):

1. Number, volume or weight of the commodities or products (e.g. sheep, lamb, wool, meat) moving between segments of the value chain;
2. value-added, which measures gross production value (GPV) and gross and net value added (GVA);
3. distribution of value-added as the products move from production or processing segment of value chain to another;
4. social indicators being mainly employment to provide estimate of the total number of jobs created along the value chain and disaggregates the number of jobs created across different actors and activities;

This paper presents a methodology for describing agricultural industries in an input-output table of sheep industry of the state of Western Australia. Data are generated from agri-food industry value chain models. The development and updating of an agri-food industry value chain model is was conducted according to methodology described by Xayavong and Islam (2009).

This sheep and lamb value chain model is based on a distributive commodity balance method. The model generates the transaction data tracking the flow of sheep and lamb and attendant products from farm sector to processing, wholesale, and export sectors. The sheep industry value chain model relies on data from the Australian Bureau of Statistics (ABS), DPIRD's economics branch (Xayavong & Islam, 2009) and Meat & Livestock Australia (MLA, 2022). This approach ensures accuracy and quality of WA's agri-food value chains because it is based on nationally validated input-output tables of ABS.

References used for Appendix A and B

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