Department of Agriculture and Food

GOVERNMENT OF WESTERN AUSTRALIA

Department for Agriculture and Food – Northern Beef Futures Valuing security of supply

Project code: **DAFWA 375**

Prepared by: PricewaterhouseCoopers (PwC)

ROYALTIES FOR REGIONS

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Department of Agriculture and Food - Northern Beef Futures

Valuing security of supply

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GOVERNMENT OF WESTERN AUSTRALIA
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1. Executive Summary

The DAFWA-NBF project is committed to identifying growth and value creation opportunities for the WA Beef industry and have engaged PwC to estimate the value of increased security of supply.

A joint PwC/NBF team have developed a WA beef value chain model to better understand the industry's potential and establish the potential value associated with changes in the security of supply.

Results indicate that, over a five to twelve year timeframe, the WA Beef industry might have the potential to grow cattle disposals, double revenue to $1.2B and increase profit by $0.5B.

A diversified market which includes Japan and China growth is achieved by first reducing exports, including those to Indonesia and Vietnam, and diverting them to the domestic market.

Greater coordination, forward contracts, identifying the right markets and securing investment together with a structured industry-wide co-creative approach will be required if the full value of the security of supply is to be achieved.

1.1 Project overview

The DAFWA-NBF project is committed to identifying growth and value creation opportunities for the WA Beef industry and have engaged PwC to estimate the value of increased security of supply.

Background

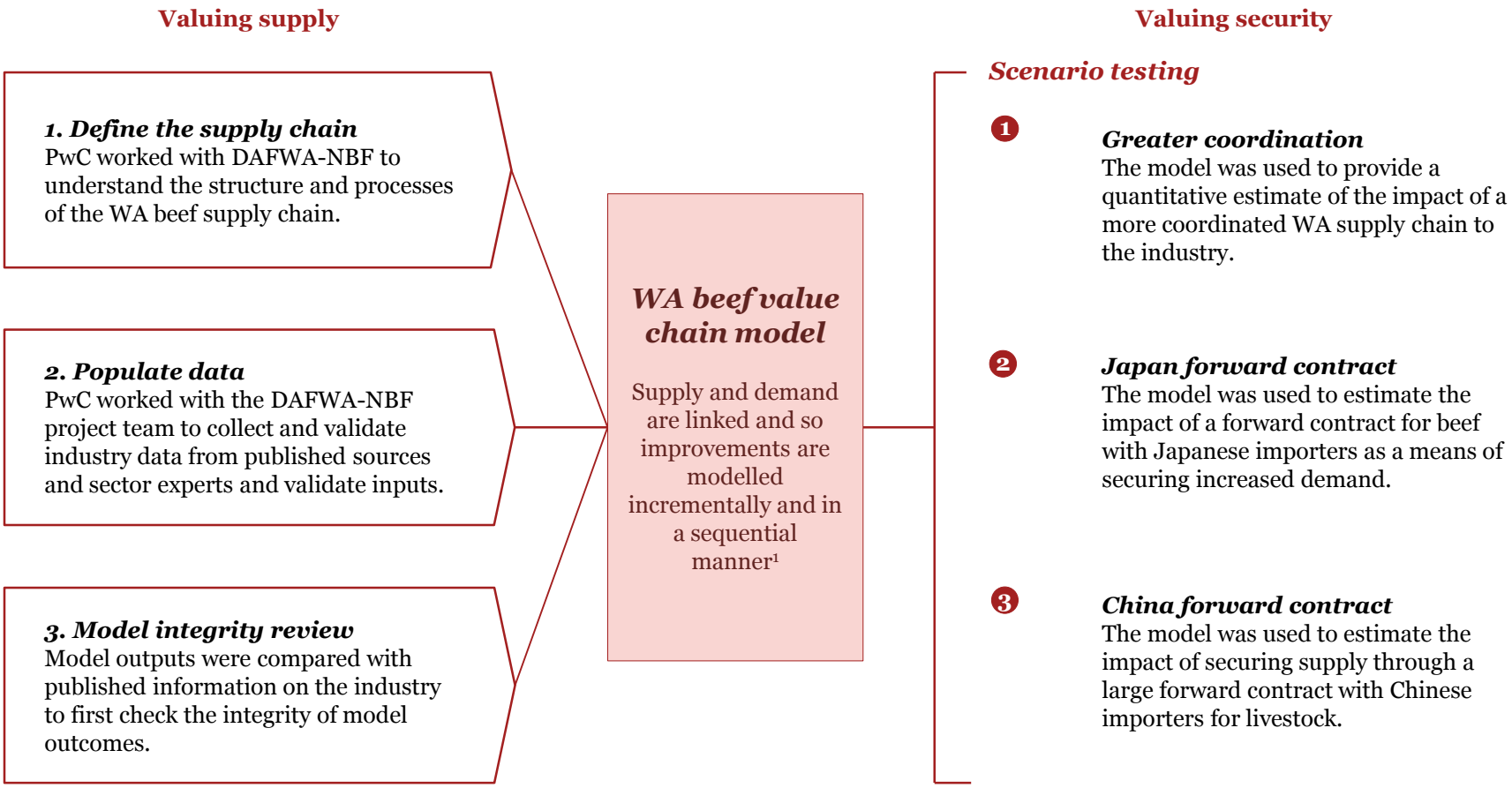
- The WA Beef industry forms an important part of the Western Australian economy, providing thousands jobs across the supply chain.
- There is a view that market price volatility and a perception that the supply chain is underdeveloped is impacting upon the industry's ability to attract the investment required to grow and realise its full potential.
- The Department of Agriculture and Food (DAFWA), with funding from the State Government's Royalties for Regions project, launched the Northern Beef Futures project (DAFWA-NBF) in August 2014 to help identify ways to promote sustainable growth of the WA Beef industry.
- The DAFWA-NBF project has focused on opportunities to transform the WA Beef industry which includes reviewing innovative business and investment models as well as exploring any benefits associated with integration of the current supply chain.

Context

- DAFWA-NBF engaged PwC to help estimate the value associated with increased security across the WA Beef supply chain
- The approach that PwC have taken to estimating the value of security of supply was as follows:
  1. Build a model capable of representing the current supply chain as a value chain and identifying constraints that appear to limit production volume growth
  2. Identify a suitable method to reduce WA beef price volatility
  3. Estimating the incremental value to the WA Beef industry associated with reduced price volatility
  4. Leverage Beef industry case study evidence to develop a reasonable scenario to support maximising WA Beef industry production volumes and estimate associated incremental value

1.2 Summary approach

A joint PwC/NBF team developed a WA beef value chain model to better understand the industry's potential and establish the potential value associated with changes in the security of supply.

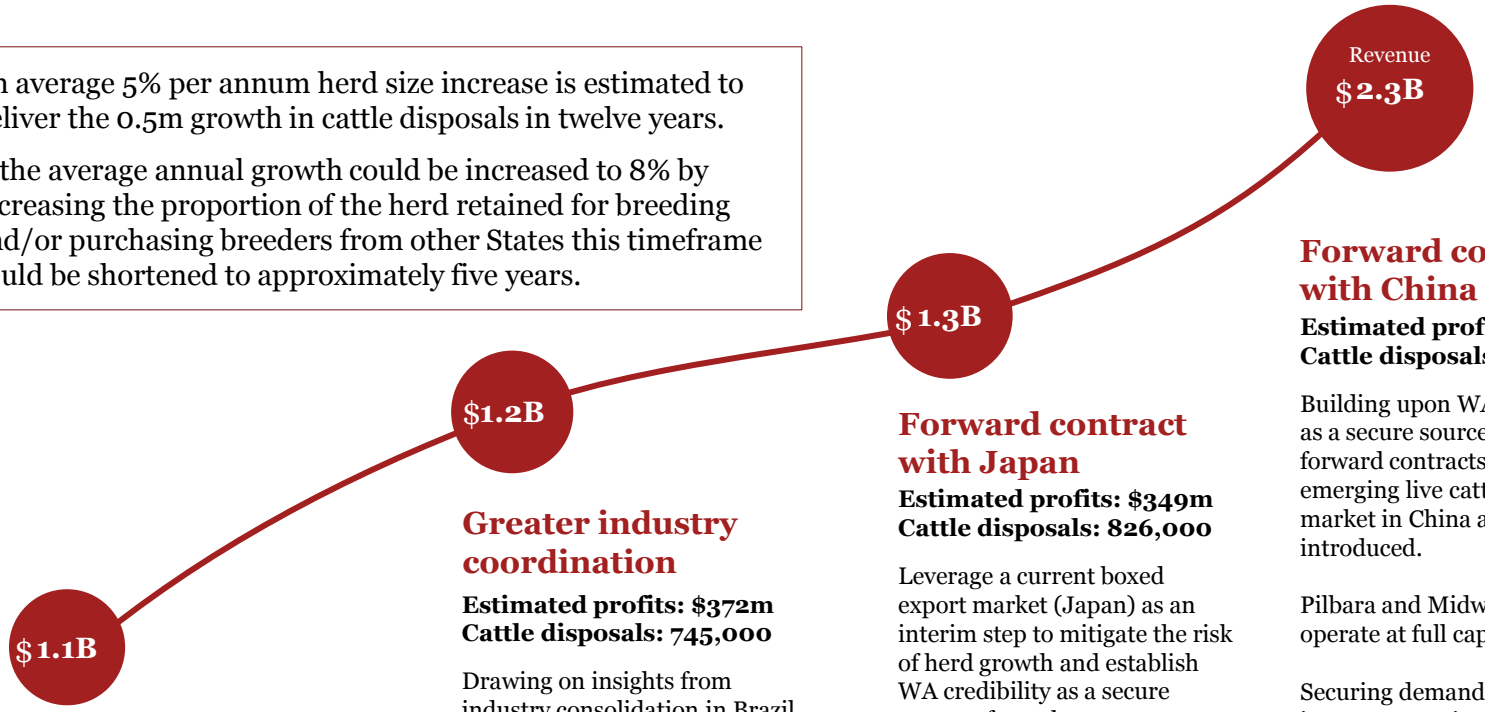


Note 1: Please refer to section 3.3 'The security of supply opportunity' below for further detail on the link between demand and supply.

1.3 Summary results

Results indicate that, over a five to twelve year timeframe, the WA Beef industry might have the potential to grow cattle disposals, double revenue to $1.2B and increase profit by $0.5B[1].

- An average 5% per annum herd size increase is estimated to deliver the 0.5m growth in cattle disposals in twelve years.
- If the average annual growth could be increased to 8% by increasing the proportion of the herd retained for breeding and/or purchasing breeders from other States this timeframe could be shortened to approximately five years.



2015 Baseline

Estimated profits: $276m
Cattle disposals: 677,000

Based on 2015 production data.

Note 1: Identified growth is dependent on a number of factors, which are outlined in this report.

Greater industry coordination

Estimated profits: $372m
Cattle disposals: 745,000

Drawing on insights from industry consolidation in Brazil, we model the impact of a more coordinated supply chain.

The increase in profits comes from leveraging domestic sales to support an increase in the herd size.

Production volumes are restricted by the current abattoir capacity of 438,000 head per annum

Forward contract with Japan

Estimated profits: $349m
Cattle disposals: 826,000

Leverage a current boxed export market (Japan) as an interim step to mitigate the risk of herd growth and establish WA credibility as a secure source of supply.

Profit falls as premium grade meat is diverted to Japan and away from a higher priced domestic market, which is now supplied with standard grade meat.

Securing demand will require investment to increase abattoir capacity by 70,000 head per annum.

Forward contract with China

Estimated profits: $671m
Cattle disposals: 1.2m

Building upon WA credibility as a secure source of supply forward contracts with an emerging live cattle export market in China are introduced.

Pilbara and Midwest farms operate at full capacity.

Securing demand will require investment to increase feedlot capacity to be able to cope with 116,000 head at any one time.

1.4 Market and product distribution

A diversified market which includes Japan and China growth is achieved by first reducing exports, including those to Indonesia and Vietnam, and diverting them to the domestic market.

Sales destination	Baseline analysis	Scenario 1: Greater coordination	Scenario 2: Japan forward contract	Scenario 3: China forward contract
Domestic	Boxed: 67,477 tonnes	Boxed: 135,179 tonnes	Boxed: 135,179 tonnes	Boxed: 135,179 tonnes
Export: Indonesia	Boxed: 6,745 tonnes	Boxed: 3,373 tonnes	Boxed: 3,373 tonnes	Boxed: 3,373 tonnes
	Live: 67,273 head	Live: 33,637 head	Live: 33,637 head	Live: 33,637 head
Export: Vietnam	Live: 72,033 head	Live: 36,016 head	Live: 36,016 head	Live: 30,016 head
Export: Japan	Boxed: 7,195 tonnes	Boxed: 3,598 tonnes	Boxed: 25,000 tonnes	Boxed: 25,000 tonnes
Export: China	Live: 0 head	Live: 0 head	Live: 0 head	Live: 400,000 head
Cattle disposals	***677,000 head***	***744,900 head***	***824,300 head***	***1,225,135 head***

1.5 Success factors

Greater coordination, forward contracts, identifying the right markets and securing investment are all key to the success of realising the WA Beef Industry opportunity.

1. Industry appetite for greater coordination

The current supply chain has capacity that could be accessed via increased industry-wide co-ordination and co-operation. The WA Beef industry will need to have the desire to work together if estimated potential growth is to be realised.

2. Identifying target markets to grow capacity

Japan is an established boxed beef export market with a desire to secure beef supply. It also represents a sophisticated trading environment to build forward contracting credibility. China represents a significant emerging market which is unable to satisfy demand for beef and is actively seeking a secure supply. A targeted approach to build trusted business relationships is essential.

3. Forward contracting to reduce volatility

The security of demand and supply are linked[1]. Forward contracts will be required to secure demand to provide the confidence the industry needs grow production to levels that can offer customers the security of supply.

4. Attracting investment

Reduced volatility can dramatically strengthen the case for investment. An appetite for investment will be required for the herd to expand sufficiently to meet the estimated future demand.

Note 1: Please refer to section 3.3 'The security of supply opportunity' below for further detail on the link between demand and supply.

1.5.1 Industry appetite for greater coordination

Modelling results show there exists capacity in the WA beef value chain to meet much greater demand, provided the sector can organise to raise throughput.

Cattle disposals	677k h/p/a	→	745k h/p/a

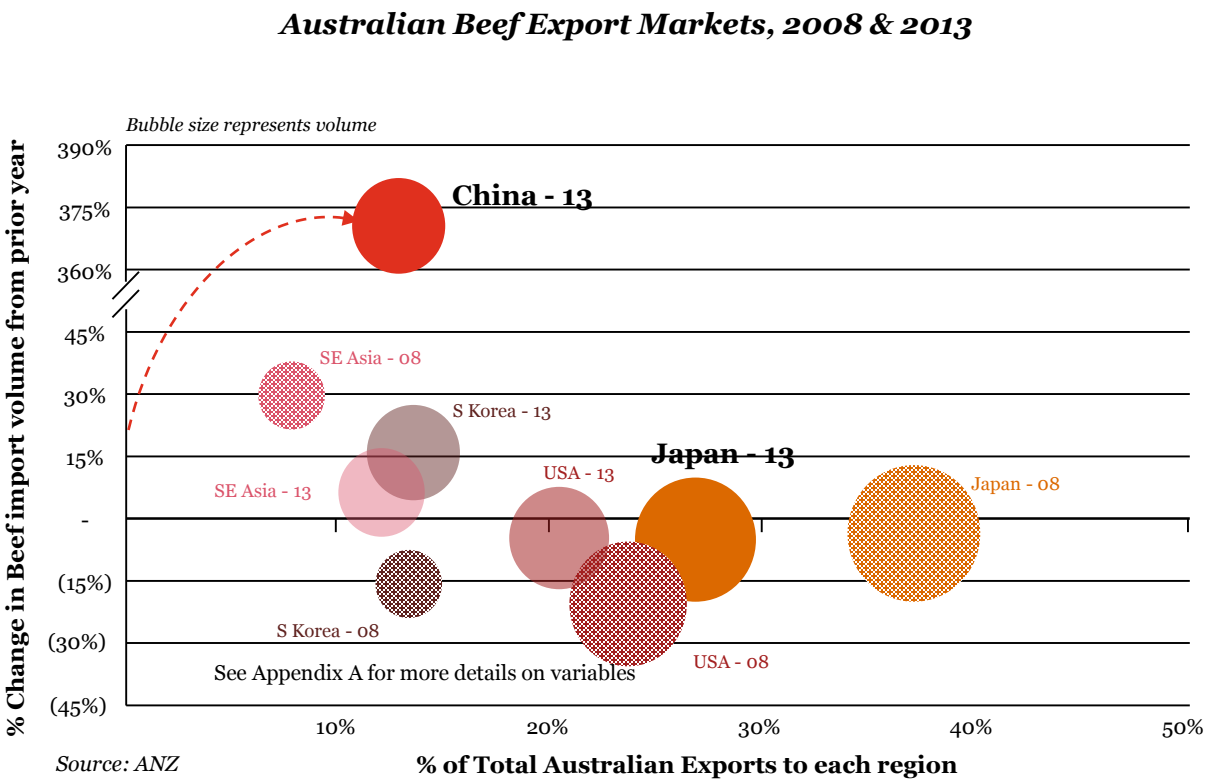
Value chain component	2015 Baseline *Throughput*[1]	Greater industry coordination *Throughput*[1]
Southwest farm	*236,398*	*247,752*
Midwest farm	*173,359*	*181,685*
Kimberley farm	*283,678*	*297,302*
Pilbara farm	*94,559*	*99,101*
Abattoir	*311,420*	*438,000*
Feedlot	*391,555*	*454,713*

Note 1: Throughput is defined as the head of cattle that pass through a value chain component in a year.

- Model results show that the WA beef supply chain has capacity to increase the number of annual cattle disposals.
- Supply chain maturity and coordination has played a key role in other sectoral transformations.
- Insight from the Australian mining industry has identified that an industry-wide understanding of the value chain is critical to incentivising greater coordination. For example, expanding feedlot and processing capacity contributes significant value. Without an industry-wide view, shared responsibility for this investment is unlikely to be recognised.
- Industry consolidation in Brazil has been driven by vertical integration undertaken by large agribusinesses.
- The provision of subsidised credit in Brazil was central to the expansion of state backed agribusinesses. For WA, this is unlikely to be an option.
- An industry-wide appetite and a supportive policy environment will be essential to raising the security of supply.

1.5.2 Identifying target markets to grow capacity

Japan and China are among the largest and fastest growing markets respectively for Australian beef exports.

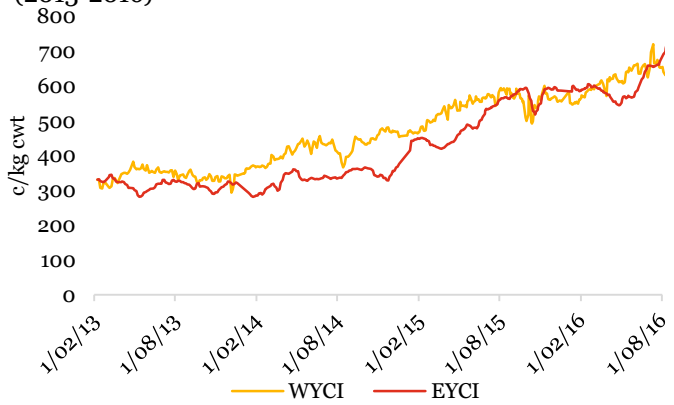


- WA's main export markets are Indonesia and Vietnam. Due to their volatility they are unable to provide the security of demand required to support large scale industry growth.
- Japan has been a key export destination since the 1990's. 16% of WA's boxed beef exports were sold to Japan in 2015.
- The share of WA's boxed beef exports to China doubled from 6% to 12% between 2014-15. Chinese demand is expected to continue to grow substantially
- Industry feedback suggests:
  - Significant appetite in both Japan and China to develop long term relationships with WA beef suppliers.
  - This appetite is likely to continue to grow, given the increasingly favourable trading relations resulting from free trade agreements.

1.5.3 Forward contracting to reduce volatility

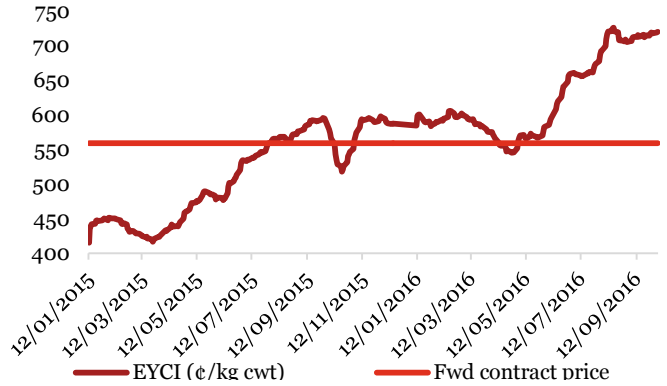
Forward contracts are used to reduce price volatility and can be applied to the WA beef supply chain.

Western and Eastern Young Cattle Indicator
(2013-2016)



- Australian and global beef prices exhibit a degree of volatility that makes predicting future prices challenging.
- This uncertainty can undermine the incentive producers have to invest in herd size to increase production given risk around potential losses
- Industry insight also suggests price volatility contributes to both producers and buyers diversifying across markets to manage the risk associated with disruptions.

EYCI price and illustrative forward contract price
(2015/16 average)



- Forward and futures contracts are used widely across sectors and industry to manage volatility.
- The basis of these arrangements is for an agreed trade to take pace in the future for a given quantity at a given price.
- Although used domestically, international forward contracts are less prevalent given foreign exchange risks.
- In some instances, a degree of variation in price may be allowed to manage the effect of currency fluctuations.

1.5.4 Attracting investment

Access to finance for capital is a recognised challenge. Economies of scale associated with greater co-ordination will improve the ability of the WA Beef industry to attract capital finance and investment.

1. Secure demand reduces investment risk

Structured arrangements between entities in the supply chains such as a cooperative can pool risks around disruption, making them easier to manage, and reduce risk to investment. This, in turn can reduce the required return due from the investment to compensate for the risk.

2. Pooling resources to meet investment demand

In addition to becoming more attractive to outside investment, greater coordination can improve the value chains ability to self finance investment needs. Improved understanding of the value chain across all participants can support excess capital in one part of the supply chain can be allocated to other parts to raise production.

3. Prioritisation of investment needs

In the case of the mining industry in Australian and Brazilian beef, greater coordination amongst all elements of the supply chain has improved the way capital has been allocated. This improvement flows from the understanding of the value created at each stage of the supply chain.

1.6 Acknowledgements 1 of 2

The model has a number of inherent limitations that can be addressed through collaboration with the WA Beef industry.

1. Data accuracy

Data has been sourced from the 2014 to 2015 period. While every effort has been made to source accurate data, some of the data will quickly become out of date, particularly for variables that are subject to volatility and/or short-term changes, such as prices, costs and some elements of production. Where this is the case, a number of assumptions have been made. A critical next step would be to work with industry participants to improve data accuracy.

2. Granularity of information

Given the objective to provide an indication of the potential size of the benefit to be gained and the availability of quality detailed data model granularity has been limited to key areas of the supply chain and aggregated geographical locations. This also includes the use of yearly averages for prices and costs. The model can be expanded as more detailed data becomes available.

3. Access to investment

To achieve the modelled levels of growth, enhancements to assets and some infrastructure will be required at all levels of the WA Beef supply chain. This includes abattoir and feedlot capacity as well as support services such as transportation. Identifying and quantifying these areas as well as establishing the criteria for securing financing or investor support will be important to validating the feasibility of the estimated growth. Financing and investor support is expected to improve with the establishment of forward contracts with Japan and China.

1.6 Acknowledgements 2 of 2

The model has a number of inherent limitations that can be addressed through collaboration with the WA Beef industry.

4. Value of security of supply from a demand perspective

Value of security will depend upon the specific customer and their current constraints. For example:

- One processor may place a large value of security as it will allow them to maximise the utilisation of their equipment and leverage economies of scale to drive down the cost of production, thereby securing greater market share and enter into long term contracts with their customers. Another producer may not value the same level of security as they feel that the growth in market share is not there or that the benefits do not outweigh the significant capital investment that would need to be made and for which finance would be difficult to secure.
- One distributor may have a mature customer network that differentiates WA beef based on known attributes such as premium grade, disease free and product traceability, and could rapidly convert additional secure supply into sustainable growth whereas another may not.

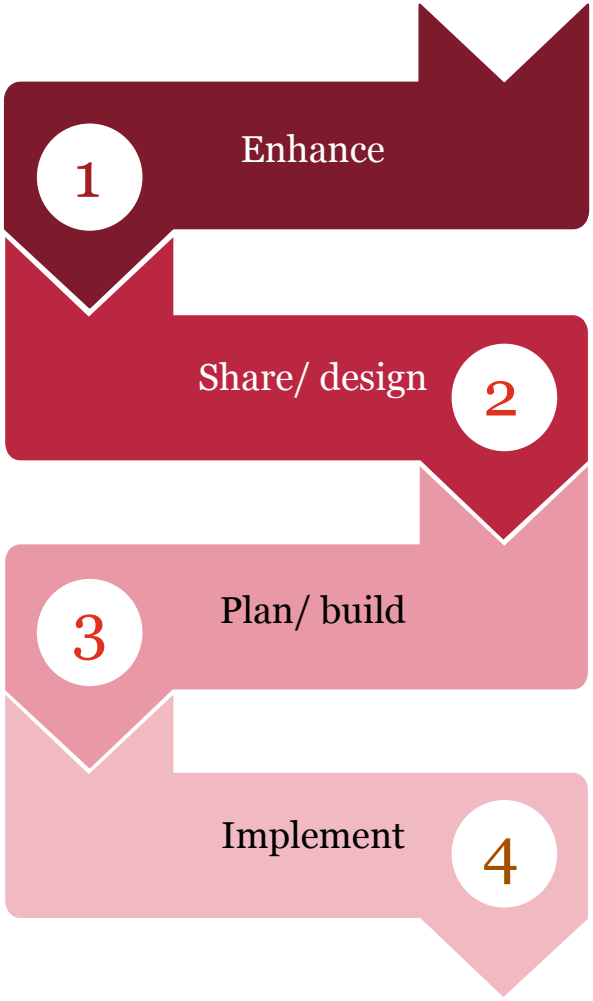
While the modelling tool is capable of factoring in the value perspective of different customers it relies on data accuracy and the willingness of supply chain participants to openly share this level of information. As relationships start to strengthen it may be possible to obtain and incorporate this data into the model.

5. Risks and opportunities

There are a number of risks and opportunities beyond industry control that could impact potential growth and are not currently factored into the model. Risks include potential market access restrictions resulting from health and safety incidents and/or unexpected changes to government policy and large currency fluctuations. Opportunities include economies of scale and innovation led productivity improvements such as potential feedlot expansion in the north through improved irrigation.

1.7 Potential road map

A structured industry-wide co-creative approach will be required if the full value of the security of supply is to be achieved.



- Consider and incorporate other DAFWA-NBF project outputs.
- Select group of relevant and representative stakeholders and present findings, establish appetite for industry growth, enhance data accuracy and agree next steps.
- Develop a stakeholder engagement and communication plan.

- Widen industry consultation, present findings, establish appetite for industry growth, enhance data accuracy and agree next steps.
- Assess regulatory criteria required to increase volumes in export markets.
- Model incremental volumes and estimate required returns.
- Hold discussions with selected potential investors and Japanese and Chinese customers.

- Design operating model.
- Develop a detailed implementation plan.
- Establish WA Beef industry governance structure.
- Establish team to develop business case.
- Obtain business case approval.
- Secure funding.

- Establish project team and governance structure.
- Execute implementation plan to realise benefits.

2. Valuing supply

In this section we develop a model of the WA beef supply chain to estimate levels of production and form the baseline of our analysis.

The model reflects data and evidence drawn from a number of sources combining published data and insight from industry participants to estimate the costs, processes, duration, materials required, seasonal factors and capacity constraints that exist at each stage of the supply chain.

Fixing the volumes and revenues to published figures for 2015, we then replicate the value of supply in 2015, quantify the flow of cattle and sales, and identify throughput at each stage of the supply chain.

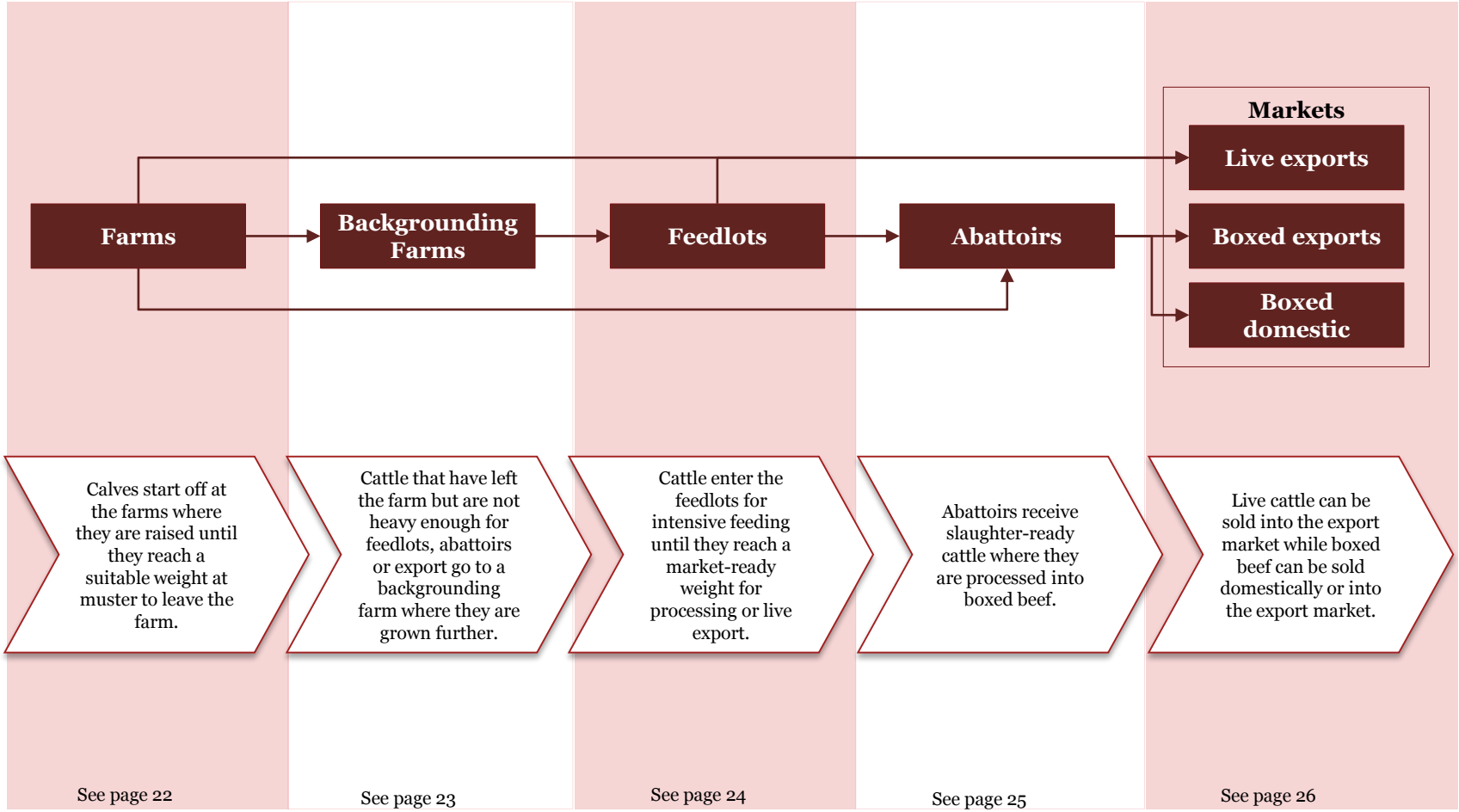
2.1 Valuation approach

A robust model of the current beef supply chain was built using a three-step process. This allows 'what-if' scenarios to be run that show the impacts on the supply chain and beef industry

	1. Define the Supply Chain	2. Populate data	3. Model integrity review
Methodology	• PwC worked with the DAFWA-NBF project team to understand the structure of the WA beef supply chain. • The functionality and outputs of the model were discussed and agreed. This formed the basis of defining the model scope, variables, assumptions and the level of detail in the model.	• PwC identified the data required to parameterise our supply chain model and its constraints. • All model inputs used were collected from sources approved by the DAFWA-NBF team and cross-checked with industry experts.	• Using validated inputs, the model's integrity was tested by comparing model generated results against 2015 published results about the WA Beef industry.
Outputs	• The WA beef value chain model replicates the flow of cattle and beef products, and the processes and materials required at each stage. • The variables and assumptions were identified and defined for each stage. • See pages 22 to 26 for an explanation of the assumptions at each stage of the supply chain.	• Data required for each assumption and variables were collected to the level of detail agreed in the previous step, and integrated into the supply chain model structure. • See Appendix A for details on data inputs.	• The outputs from the value chain model replicate 2015 published results. • The low variance in outputs indicate a robust model. • See page 27 for a comparison of model outputs and published outputs.

2.2 Value chain – structure

The value chain model reflects each of the critical stages of production in the WA Beef industry.

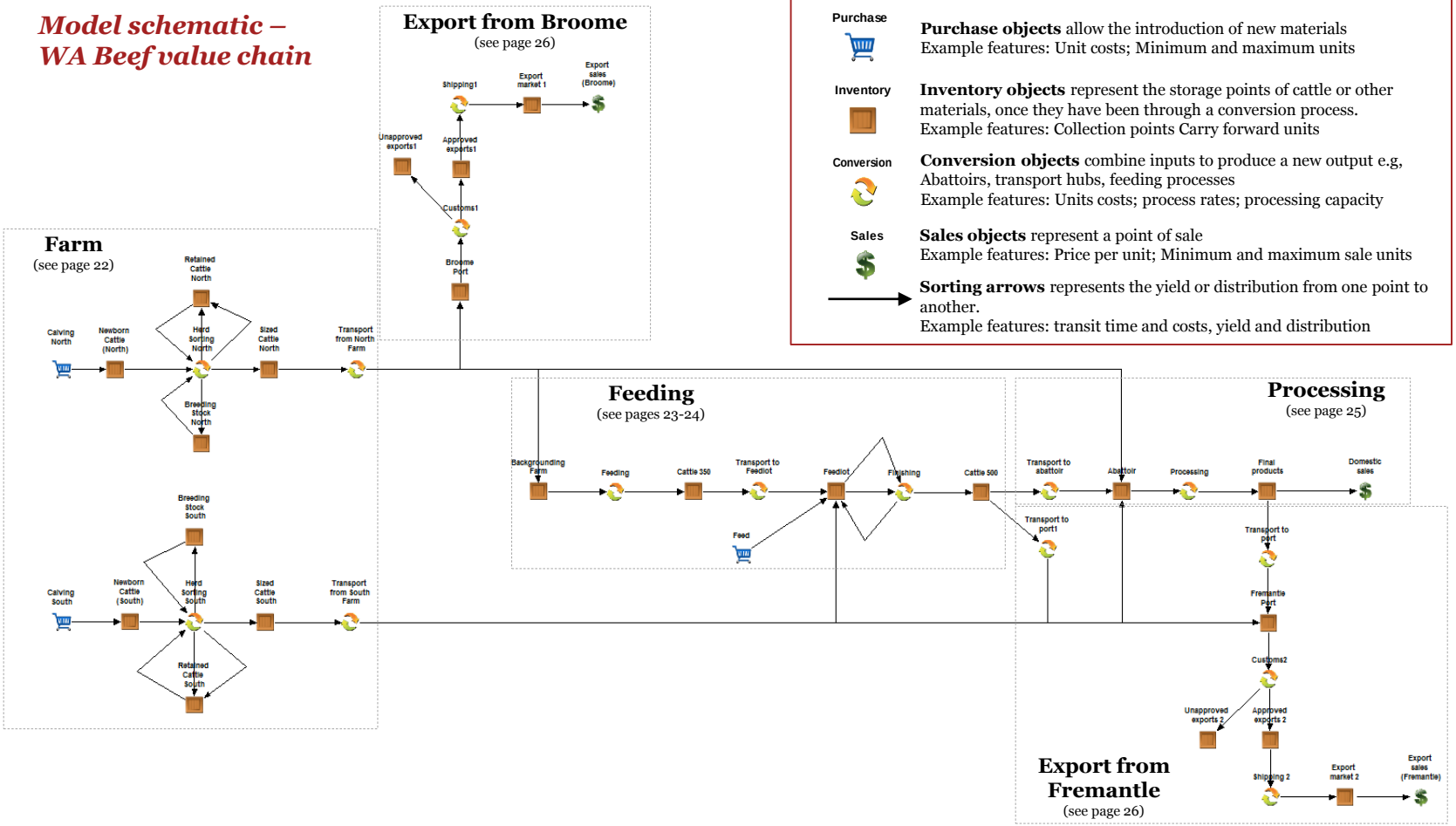


See page 20 for value chain model schematic

2.3 Model overview – Schematic

The value chain model computes volumes, costs and activities at each stage of the process to enable scenario testing and identify industry impacts.

Model schematic – WA Beef value chain



Key

Purchase

Purchase objects allow the introduction of new materials
Example features: Unit costs; Minimum and maximum units

Inventory

Inventory objects represent the storage points of cattle or other materials, once they have been through a conversion process.
Example features: Collection points Carry forward units

Conversion

Conversion objects combine inputs to produce a new output e.g, Abattoirs, transport hubs, feeding processes
Example features: Units costs; process rates; processing capacity

Sales

Sales objects represent a point of sale
Example features: Price per unit; Minimum and maximum sale units

Sorting arrows represents the yield or distribution from one point to another.
Example features: transit time and costs, yield and distribution

2.3 Model overview – Variables

Each element of the model has five types of variable. Each can be either be a fixed or choice variable.

1. **Volumes:** Quantity of cattle at each stage of the supply chain.
2. **Capacities:** Capacity of each location in the supply chain.
3. **Costs / Prices:** Costs of processes and materials and prices of final products in the market.
4. **Distribution:** Distribution of cattle within the supply chain.
5. **Rates / Processes:** The rates and constraints of processes incorporated throughout the supply chain model.

Each variable can either be a fixed of choice variable:

- **Fixed variable:** These variables are assumed to be outside the immediate policy framework, and control of those engaged in the WA supply chain. Unless stated, we assume these to be fixed in every scenario
- **Choice variables:** We assume these variables are within the control of either those involved in the WA value chain, or government policy. These are variables that can be adjusted depending on the scenario.

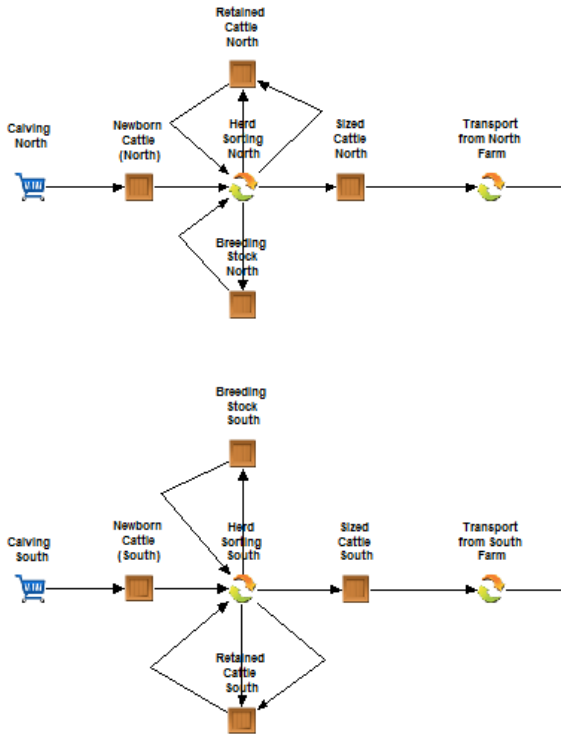
Note on sources: At each stage of the model, we have sought to reflect standard industry practice e.g. the industry standard weight for penalty free entry to an abattoir.

See Appendix A for more details on variables

2.4 Model detail – Farms

Cattle start off at the farms as calves where they are raised as calves until they reach a suitable weight at muster to leave the farm.

Model schematic - Farming



See Appendix A for more details on model inputs

Key model features

Farm capacity: The northern and southern farms of the model represent two subregions each. Northern farms are split into the Pilbara and Kimberley, and southern farms the Mid-west and Southwest. Each subregions represents the aggregate capacity of all farms and cattle stations in that area.

Breeding: We model new calves entering the model at each muster and stay on the farm until they reach the required weight to move to the next stage of the model. Breeding costs are assumed to be the sum of feeding costs to meet the defined weight to progress to the next stage of the model.

Herd composition: steers, heifers and cows that enter the supply chain for live export or for processing. We assume southern farms produce Bos Taurus, and northern farms Bos Indicus.

Muster periods: The model assumes two muster periods in the north, and two muster periods in the south.

Weights at muster: We assume a fixed distribution of cattle weights at each muster across five categories. Cattle in the lowest weight category in each farm are retained and grown further until the next muster period.

Transport from farm: The model determines the next step made by an animal is based on their weight at muster. Transport costs reflect industry standards and distance travelled.

2.4 Model detail – Backgrounding farms

Cattle that have left the farm but are not heavy enough for feedlots, abattoirs or export go to a backgrounding farm where they are grown further.

Model schematic - Backgrounding

From northern farms

Key model features

Cattle in backgrounding farm: Cattle between the weights of 150kg and 300kg can enter backgrounding farms for further growth before going to the feedlots. Based on industry insight, we assume all cattle are Bos Indicus to reduce complexity, given the low proportion of southern cattle entering backgrounding.

Backgrounding capacity: We model the capacity for backgrounding as the aggregate capacity of all southern backgrounding farms, drawn from industry data.

Cattle growth: Based on industry data, we assume that cattle grow at a rate of 0.6kg/day. The duration at which they are in this stage of the supply chain is determined by their entry and exit weights.

Feeding months: Because of seasonal conditions we assume that feed is only available between the months of May to November.

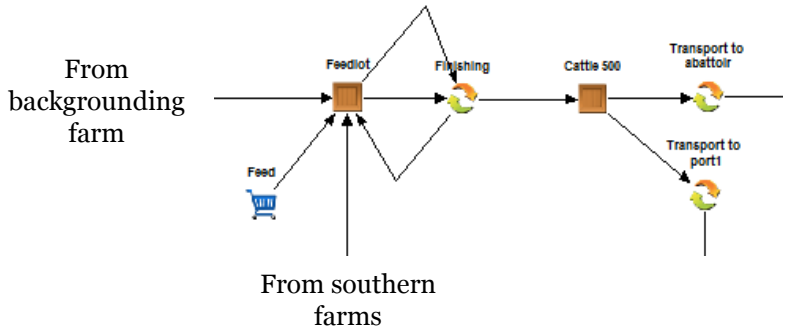
Transport to feedlot: The exit weight at backgrounding is 350kg. At this point, the cattle exit backgrounding farms and are transported to the feedlot. Transport costs used in the model are the average cost to transport cattle from a backgrounding farm in the south to a feedlot in the south.

See Appendix A for more details on model inputs

2.4 Model detail – Feedlot

Cattle enter the feedlots for intensive feeding until they reach a slaughter-ready weight for processing or live export.

Model schematic- Feedlot



Key model features

Cattle in feedlot: Cattle can enter the feedlots directly from the farms or after backgrounding. We assume the minimum entry weight for cattle into the feedlot is 350kg, based on standard industry practice.

Feedlot capacity: Using industry data, feedlot capacity in the model is the aggregate capacity of all southern WA feedlots.

Cattle growth: The exit weight for all cattle at feedlots is 500kg. It is assumed that all cattle grow in feedlots at a rate of 1.6kg/day. We assume that entry weight and rate of growth determines how long each animal is at a feedlot. The unit cost for each animal is modelled as the average cost of feed per tonne and duration of time spent at the feedlot.

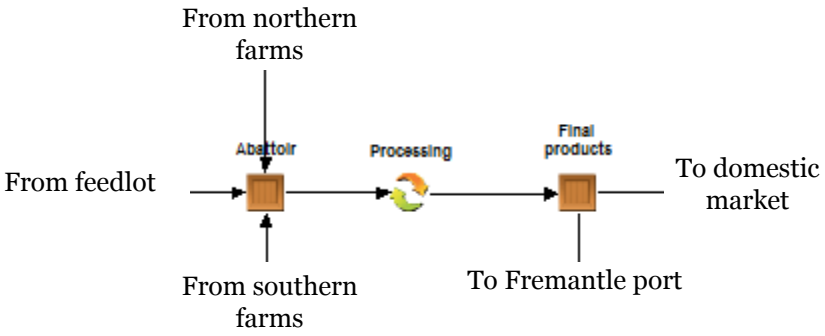
Transport from feedlot: Once the cattle have reached their exit weight of 500kg, the model decides on the next step; either transport to an abattoir for processing or to Fremantle port for live export. Average costs to transport a cattle from a feedlot in the south to an abattoir in the south or to Fremantle port are estimated from industry data.

See Appendix A for more details on model inputs

2.4 Model detail – Abattoirs

Abattoirs receive slaughter-ready cattle where they are processed into boxed beef.

Model schematic - Abattoirs



Key model features

Cattle at abattoir: Cattle can enter the abattoir from the feedlot or directly from the farms at a minimum weight of 400kg.

Abattoir capacity: Given the primacy of the abattoirs in the south, we assume abattoir capacity as the aggregate capacity of all southern WA abattoirs.

Processing: Based on industry data, we assume cattle are processed with a carcass weight of 54% of live weight, and have a yield of 75%. Each animal is processed into 18 final products.

Processing cost: Inferring from industry data, we model the cost of processing cattle differs by weight. Cattle under 500kg incur a penalty cost.

Transport from abattoir: Once processed, beef products can be sold into the domestic market or be transported to Fremantle port for export as boxed beef. Transport costs are based on distance travelled and estimated from industry data.

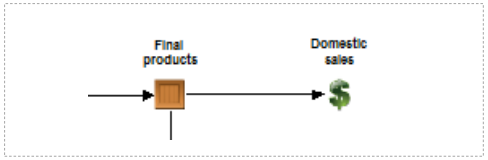
See Appendix A for more details on model inputs

2.4 Model detail – Markets

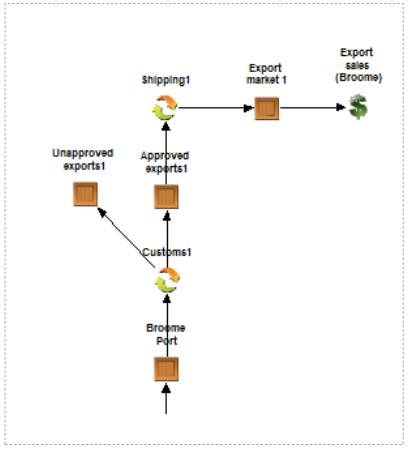
Live cattle can be sold into the export market while boxed beef can be sold domestically or into the export market.

Model schematic - Markets

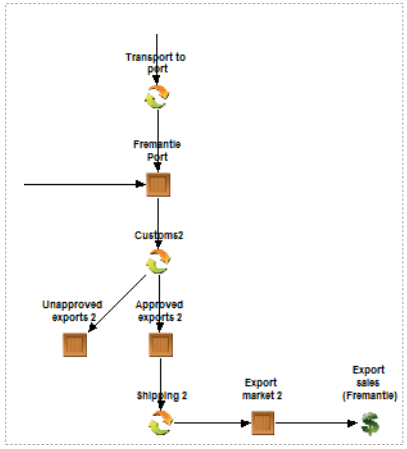
Domestic market



Export from Broome



Export from Fremantle



Key model features

Sales: We model three points of sale: the domestic market, export from Broome port and export from Fremantle port. Export sales can be boxed or live.

Domestic: Boxed beef can be sold into the domestic market. Prices differ by cut and breed of cattle. Bos Taurus is assumed to be of higher quality and thus commands a higher price for some cuts.

Broome: Bos Indicus live cattle from the northern farms between the weights of 250kg to 350kg, and 400-450kg are exported from Broome and be sold to Indonesia, Vietnam or other markets.

Fremantle: We model boxed beef and live cattle of both breeds between the weights of 450-500kg are exported from Fremantle and can be sold to Korea, Japan, Indonesia, the US, Vietnam or other markets.

Shipping: Shipping cost for live exports are dependant on cattle weight. Shipping costs for boxed beef are standardised per tonne. Each cost is based on the approximate Cost and Freight (CFR) price for each.

See Appendix A for more details on model inputs

2.5 Model verification

Model outputs were compared to 2015 published results. Low variances levels confirm a model integrity sufficient for use for supply security scenarios.

Comparison of model outputs and published data

	Description	Expected output [1]	Model output [2]	Variance (Volume/Revenue)	Variance (Percentage)
Boxed beef exports	Korea volume	7,800 tonnes	8,094 tonnes	+ 294 tonnes	4%
	Korea revenue	$29m	$30m	+ 1 m	3%
	Japan volume	6,900 tonnes	7,195 tonnes	+ 295 tonnes	4%
	Japan revenue	$28m	$29m	+ 1 m	4%
	US volume	6,300 tonnes	6,745 tonnes	+ 445 tonnes	7%
	US revenue	$30m	$32m	+ 2 m	7%
	Indonesia volume	6,300 tonnes	6,745 tonnes	+ 445 tonnes	7%
	Indonesia revenue	$25m	$27m	+ 2 m	8%
	Other market volume	16,000 tonnes	16,189 tonnes	+189 tonnes	1%
	Other market revenue	$71m	$72m	+ 1 m	1%
Live exports from Broome	Indonesia volume	55,000 head	55,465 head	465 head	1%
	Indonesia revenue	$47m	$47m	0 m	0%
	Vietnam volume	35,000 head	35,296 head	+ 296 head	1%
	Vietnam revenue	$29m	$29m	0 m	0%
	Other market volume	35,100 head	35,296 head	+ 196 head	1%
	Other market revenue	$34m	$35m	+1 m	0%
Live exports from Fremantle	Indonesia volume	12,000 head	11,808 head	- 192 head	-2%
	Indonesia revenue	$11m	$11m	0 m	0%
	Vietnam volume	37,000 head	36,727 head	- 273 head	-1%
	Vietnam revenue	$45m	$45m	0 m	0%
	Other market volume	84,200 head	$82,658	- 1542 head	-2%
	Other market revenue	$86m	$85m	- 1 m	0%

Key model features

The model was built with certain variables fixed to published results from 2015, such as the proportion of live cattle export to slaughter export. The volume and revenue results from the model were compared with published results to test model the model's accuracy and integrity.

The table shows the comparison between model generated output and output from 2015 published figures.

The low variance between actuals and model outputs indicates that the model was built and set up properly, and is robust enough to be used to conduct scenario testing.

Source:
1 – See Appendix B, Industry publication 2015, rounded to 000's tonnes and $m.
2 – See Appendix B, Model results – Baseline 2015. rounded to tonnes and $m.

3. Valuing security

In this section we:

- *Explore the link between demand and supply*
- *Leverage case study comparisons to develop three sequential scenarios that incrementally raise the security of supply of WA beef*
- *Use our model to estimate the associated incremental scenario values*

See Appendix B for more details on detailed model outputs
See Appendix C for more details on case studies

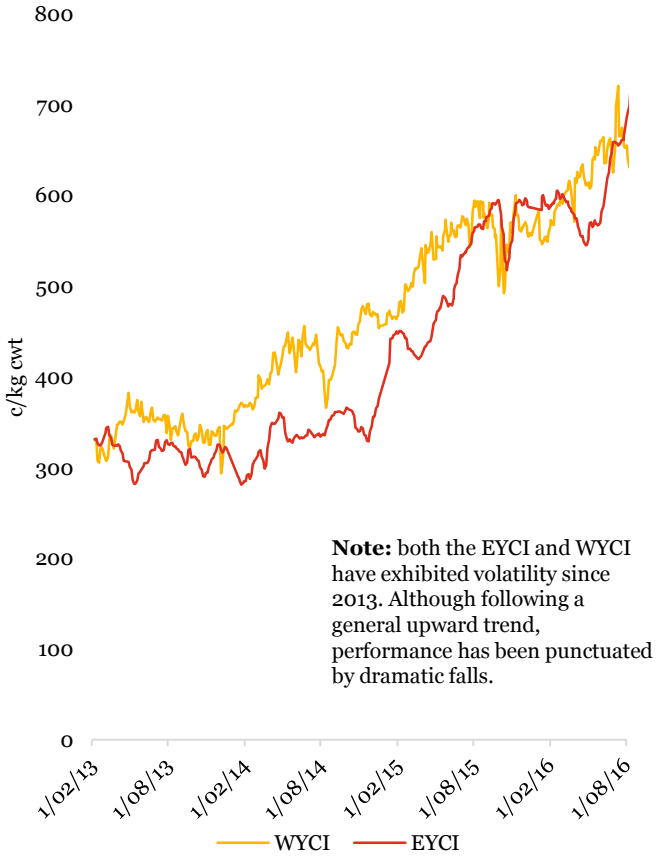
3.1 Context

The WA Beef industry is relatively small in national terms and maintains a domestic market focus. Cattle prices have more than doubled over the last three years.

Overview of the WA beef value chain

- WA beef prices have moved on general upward trend during the last 5 years. Data show that Australian beef prices in 2015 were among some of the highest on record, but have also exhibited volatility during the course of the last year[1].
- The state supply chain is numerous, with around 3,900 business involved in cattle production[2]. The WA herd size has remained stable at around two million for the past decade[4].
- WA beef accounted for around 4.5% of the total Australian beef produced in 2015 with around half being exported, lower than the approximate 75% national production[3].
- Although focussed on the domestic market, WA accounts for a relatively small proportion of beef produced for national consumption, with WA production accounting for around 10% of the national market.

Western and Eastern Young Cattle Indicator
(2013-2016)



Note: both the EYCI and WYCI have exhibited volatility since 2013. Although following a general upward trend, performance has been punctuated by dramatic falls.

Source: Meat and Livestock Australia

Note 1: Meat and livestock Australia, WYCI market report, 2016
Note 2: DAFWA analysis, the West Australian beef industry, 2016
Note 3: Meat and livestock Australia, cattle industry projections, 2016
Note 4: DAFWA analysis, the West Australian beef industry

3.2 2015 baseline analysis

Analysis of 2015 baseline model shows that the industry operated below capacity which is likely the result of a producer strategy to diversify sales across markets to improve income security.

Value chain baseline

Analysis

- Analysis of the 2015 baseline shows that industry profits in 2015 were around $276mn. This is less than the maximum potential profit of $334m.
- Our modelling indicates the sector operated below capacity and that only the Midwest farms and abattoirs exceeded a 50% throughput rate.

Observations

While achieving optimal profits is unlikely, evidence suggests that there are likely to be a number of factors limiting the ability of producers to raise profits further:

- Sales strategy to manage risk: Anecdotal evidence from industry contacts suggests producers sacrifice profit to maintain a share in diverse markets to manage the risk of demand shocks or changes in price.
- Short time horizons: forward contracting appears to play a limited role for WA producers, with a significant share of trade taking place at spot prices. Lack of legal underpinning to long-term relationships can lead to disruption as producers switch production between buyers depending on price.
- Consumers looking to establish long term large volume commitments are unlikely to purchase through the current spot market.

Volumes and capacity throughput - 2015 baseline

Supply chain	Head[2]	Rate[2]
Southwest farm	236,398	36.1%
Midwest farm	173,359	73.2%
Kimberley	283,678	40.2%
Pilbara farm	94,559	27.4%
Abattoir	311,420	71.1%
Feedlot	391,555	43.1%

Note 1: See Appendix B for more result details

Note 2: Throughput 'head' is defined as the heads of cattle that pass through a value chain component in a year. Throughput 'rate' is the total head that pass through a value chain component as a percentage of its total estimated capacity

3.3 The security of supply opportunity

Supply and demand are linked and so improvements are modelled incrementally and in a sequential manner.

- Historic data show spot prices for beef can exhibit substantial volatility. As prices move to equate supply and demand, it is likely this volatility reflects frequent underlying mismatches between both.
- For sectors such as beef with long lead-in production times, this volatility can also reflect mismatches in expectations between consumers and producers given the challenge of predicting future supply and demand, as well as the effect of unexpected disruptions.
- On the supply side, the availability of inputs such as feed, transportation, and cattle can be a key source of uncertainty and disruption, particularly in fragmented, open sourcing supply chains. Measures, such as greater supply chain coordination, can be taken to enhance the security of supply, and safeguard against unexpected disruptions.
- The relationship between supply and demand means the value of increased security of supply also depends on demand. The ability to plan production and minimise disruption in a market with volatile demand is likely to create little additional value.
- Securing the full value of security of supply therefore depends on the degree to which improvements in supply are combined with reduced volatility and increased predictability in demand.
- To reflect this relationship, we model the impact of incremental improvements in both the security of supply and demand in a sequential manner to reflect a likely strategy for implementation.

3.4 Scenario overview

A 2015 baseline and case study comparisons were used to develop three sequential scenarios that incrementally raise the security of supply of WA beef.

2015 Baseline	Comparing against 2015 actuals, we identify how the industry performed and where potential improvements might be made on existing prices, risk management strategies and supply chain structure. Using 2015 sector output as a basis, we model progressive increases to the security of supply to identify the impact and value creation in comparison to the 2015 baseline.
Scenario 1: Greater coordination	We assume that raising the security of supply, by improving supply chain coordination, reduces disruption and allows better sales targeting to raise profits. We assume the gains from increasing security of supply via supply side measures become exhausted once abattoir capacity is reached.
Scenario 2: Japan forward contract	We assume that increasing security of supply beyond the previous scenario realistically requires an increase in security of demand. Using the conditions of the Australia-Japan Economic Partnership Agreement, we test the impact of the large forward contract with Japanese importers to extend secure supply for boxed beef.
Scenario 3: China forward contract	We assume that meeting the demand required for the forward contract with Japan enhances the credibility of WA as a source of secure supply. This allows WA producers to negotiate and secure demand of Chinese importers through a significant contract to make use of WA's excess capacity, in line with conditions of the Australia-China Free Trade Agreement.

See Appendix C for more details on case studies

3.5 Scenario 1: Greater industry coordination

This scenario assumes that greater sector coordination enhances security of supply and investment, secures prices, and reduces the need to diversify sales.

Rationale

- Analysis of the 2015 industry suggests scope to improve sales revenue and profits from a more effective use of existing infrastructure.
- Drawing on insights from industry transformation in Brazil, we assume greater coordination across the WA sector, such as through a cooperative or longer-term less relationships could enable producers to reduce disruption and improve the security of supply.
- We assume that while coordination enhances performance, it does not eliminate risk completely. As such, we impose a minimum diversity of sales to manage the uncertainty.

Case study insights: Brazil

- The Brazilian beef industry has undergone significant growth since the late 1990's driven by industry consolidation and supply chain integration.
- Greater supply chain coordination enabled the sector to raise production, reduce costs and increase market share. Further details can be found in Appendix B.

Scenario assumptions

To model the effect of greater coordination on the 2015 baseline model, we assume the sector is able to optimise profit subject to the following constraints imposed to manage risk:

- Domestic prices are fixed at the 2015 average, and are known to producers.
- WA beef is traded nationally and a 1% increase in supply leads to a 0.8% fall in prices[2].
- A minimum of domestic sales at 32,500 tonnes (50% of 2015 quantity[1])
- A minimum of boxed exports at 21,500 tonnes (50% of 2015 quantity)
- A minimum of live exports at 130,000 cattle (50% of 2015 quantity)
- Maximum live exports to Indonesia at 67,000 head (2015 quantity)

Note: we assume the herd size is not fixed - greater coordination facilitates investment in the herd to meet extra demand.

Note 1: DAFWA, West Australian beef commentary
Note 2: For a review of beef price elasticities, see Zhao, Griffith and Mullen, University of New England, 2001

3.5 Scenario 1 – Results

Minimising the need to diversify sales increases domestic sales to take advantage of high prices and investment raises the herd size to abattoir capacity.

Impact on the value chain

Results:

- Under the assumptions of this scenario, model results suggest that profits could have been $372m in 2015.
- Given greater price certainty, model results imply that the industry would choose to sell more of the production domestically to take advantage of high prices in the short term. This results in livestock exports being diverted from Indonesia and Vietnam.
- The supply from WA to the domestic Australian market increases from 10% to 17%. This is relatively small and so is unlikely to have a significant impact on domestic prices.
- This supply growth is likely to translate into a minimal impact on prices. Results show the volume of domestic sales more than doubling from 62,000 tonnes to 135,000 tonnes.
- Removing limits to the herd size raises the number of cattle disposals from 677,000 head to 745,000 head. Under these assumptions, the binding constraint to production growth is abattoir capacity.

Observations:

- In addition to these gains from coordination, insight from the Brazil case study suggests greater coordination is likely to be a pre-condition to securing greater demand in export markets. Successful coordination should enhance WA's credibility as a source of secure supply and provide a focal point for large negotiations with potential customers.

Volumes and capacity under greater coordination

Value chain component	Scenario result		Change on previous scenario	
	Head[2]	Rate[2]	Head[2]	Rate[2]
Southwest farm	247,752	37.8%	+11,353	+1.7%
Midwest farm	181,685	76.7%	+8,326	+3.5%
Kimberley	297,302	42.1%	+13,624	+1.9%
Pilbara farm	99,101	28.7%	+4,541	+1.3%
Abattoir	438,000	100.0%	+126,580	+28.9%
Feedlot	454,713	48.3%	+63,158	+5.2%

Note 1: See Appendix B for more result details

Note 2: Throughput 'head' is defined as the heads of cattle that pass through a value chain component in a year. Throughput 'rate' is the total head that pass through a value chain component as a percentage of its total estimated capacity

3.6 Scenario 2 – Japan forward contract

This scenario assumes a forward contract with Japan for 25,000 tonnes of high quality beef and sufficient investment to meet contract demand.

Rationale

- Drawing on case study insight, we develop a scenario in which the next step for industry growth through secure supply requires greater security of demand.
- We assume that the greater credibility gained from industry coordination provides a platform for negotiation of large scale forward contracts (in the same style as trade in the Chicago Mercantile Exchange) in markets beyond Australia.
- Japanese interest in securing the supply of beef has increased following the Japan/Australia Economic Partnership Agreement (EPA)[1]. Japan is a net beef importer and faces competition to secure supply given exchange rate and thus price volatility.

Case study insight: CME cattle futures

- Forward (or futures) contracts, such as those traded on the Chicago Mercantile Exchange reduce uncertainty for producers with long lead-in times by agreeing future prices, volumes and delivery dates.
- Similar measures introduced in Australia came to an end were end in 2009, however new arrangements are under consideration.

See Appendix C for more case study details

Scenario assumptions

To model the impact of a large forward contract, we build on the assumptions from scenario 1 for greater coordination, and alter the Japan sales element of the model to reflect the following:

- Forward contract agreed with Japanese importers for 25,000 tonnes each year of Bos Taurus beef in particular to reflect the Japanese preference for high quality beef. Under the EPA, an increase in tariffs is triggered when beef exports exceed a certain threshold. Data from the US Department of Agriculture show that Australian exports were under the threshold by about 30,000 tonnes in 2015[2]
- A contract price average of $6/kg for chilled or frozen beef cuts, below the average price of the Australian beef imported by Japan in 2015 of $7.47. An offal import price of $9/kg - below the estimated average price of $9.70 price for 2015.
- We also assume that any binding capacity constraints on production resulting from the production growth in from scenario 1 are overcome to meet the demand of this contract and the model moves to a new steady state. Any investment required to expand production is not included in model cost calculations.

Note 1: Source, PwC Japan desk
Note 2: USDA, Japan livestock and products annual, 2016

3.6 Scenario 2 – results

Under this scenario, total disposals and revenue increase, however profits fall due to high quality beef being diverted from domestic sales to meet contract demand.

Impact on the value chain

Results:

- A forward contract with Japan raises production to 826,000 cattle disposals.
- To meet the needs of the forward contract, WA abattoir capacity has to increase from 438,000 head to around 500,000 head to meet demand.
- Contract demand for higher quality beef means sales are diverted from the domestic market. Domestic demand is met with Bos Indicus beef from under-utilised farms in the north

Observations:

- Diversion means that under this scenario of secure supply, sector profits are an estimated $349m per annum, slightly lower than the $371m secured in the previous scenario through greater coordination.
- Despite lower profits, a forward contract of this type with Japan represents a required step to increase the credibility of the sector to deliver contracts, and increase the likelihood of further opportunities to secure supply.
- Given this, we maintain the conditions for the forward contract with Japan while testing the feasibility of a forward contract with China in the next scenario.

Volumes and capacity throughput under Japan forward contract

Value chain component	Scenario result (Throughput)		Change on previous scenario	
	Head[2]	Rate[2]	Head[2]	Rate[2]
Southwest farm	274,781	42.0%	+27,030	+4.1%
Midwest farm	201,506	85.0%	+19,822	+8.4%
Kimberley farm	329,738	46.7%	+32,435	+4.6%
Pilbara farm	109,913	31.9%	+10,812	+3.1%
Abattoir	501,346	100.0%	+63,346	0%
Feedlot	514,604	54.4%	+59,891	+6.1%

Note 1: See Appendix B for more result details

Note 2: Throughput 'head' is defined as the heads of cattle that pass through a value chain component in a year. Throughput 'rate' is the total head that pass through a value chain component as a percentage of its total estimated capacity

3.7 Scenario 3 – China forward contract

The scenario assumes an annual forward contract with Chinese importers of 400,00 head.

Rationale for scenario

- We assume that the credibility gained through the forward contract with Japan, provides a basis for the further step to expand secure supply, via securing demand.
- Industry feedback highlights security of supply as a key issue for Chinese importers. Livestock importers require large, regular shipments that adhere to health and safety regulations in order to maximise abattoir throughput rate.
- Based on potential growth in livestock exports to China of 1m per annum, we assume a significant proportion of these exports come from WA given excess capacity and the existing shipping routes.

Industry insight: Chinese partnering

- Feedback from participants at the September 2016 World Meat Industry Conference in Beijing identified interest from a number of commercial partners to secure the supply of beef from WA. Greater detail and analysis of the Chinese market can be found in Appendix C.
- Potential partners include: ecommerce companies, large processors, financial institutions and large agribusinesses.

Scenario assumptions

In line with previous assumptions and the likely sequencing of greater security of supply, we assume industry capacity stands at the levels used in previous scenarios. The key assumptions used in these scenarios are:

- Forward contract agreed with China for 400,000 head of 500kg+ slaughter-ready cattle per annum to meet the capacity of around capacity of four to five abattoirs on the south China coast.
- We also assume a forward contract price of $5/kg live weight FOB, which is below the current spot price in China of around $7/kg[2].
- We assume that there are no constraints on shipping capacity and that sufficient vessels exists to meet the transit needs at current industry costs.

Meeting additional demand of this scale will likely require significant reorganisation of the herd between farms to manage costs.

To reflect this, we relax the assumptions around the distribution of the herd, and allow the model to choose the optimal source of cattle amongst the farms/stations in the north and in the south.

Note 1: Industry participants, CIMIE conference, Beijing, 27-29 September
Note 2: Ministry of Agriculture, 2016

3.7 Scenario 3 – results

The size of the envisaged forward contract exhausts much of the excess capacity in WA. Results indicate developing secure supply to meet this demand would require substantial investment

Impact on the value chain

Results:

- Meeting this demand, raises the number of cattle disposals each year, from 826,000 to 1.2 million head, which is still within the carrying capacity of the WA farm land. However, the demand for the livestock raises the cattle volumes to the estimated carrying capacity of farms in the Pilbara and Southwest.
- A forward contract for 400,000 head requires an expansion in the feedlot capacity to 116,000 head at any one time.
- Sector wide profits increase substantially - growing to $671m from $372m secured under the scenario of greater coordination and a Japan forward contract.

Observations:

- Under these assumptions, the optimal choice is to increase the herd numbers in the Kimberley, Pilbara and Southwest, while reducing the number of cattle drawn from the Midwest. This reflects the need to produce northern Bos Indicus cattle to meet livestock export demand in existing markets, while minimising transport costs through prioritising herd growth at the most southerly farm/stations in each region.

Volumes and capacity throughput under China forward contract

Value chain component	Scenario result (Throughput)		Change on previous scenario	
	Head[2]	Rate[2]	Head[2]	Rate[2]
Southwest farm	1,062,248	100.0%	+407,248	58.1%
Midwest farm	34,908	45.7%	- 73,388	-39.3%
Kimberley	421,861	50.9%	+62,279	4.2%
Pilbara farm	590,899	100.0%	+245,899	68.1%
Abattoir	564,693	100.0%	+63,346	0%
Feedlot	1,275,775	94.3%	+380,586	39.9%

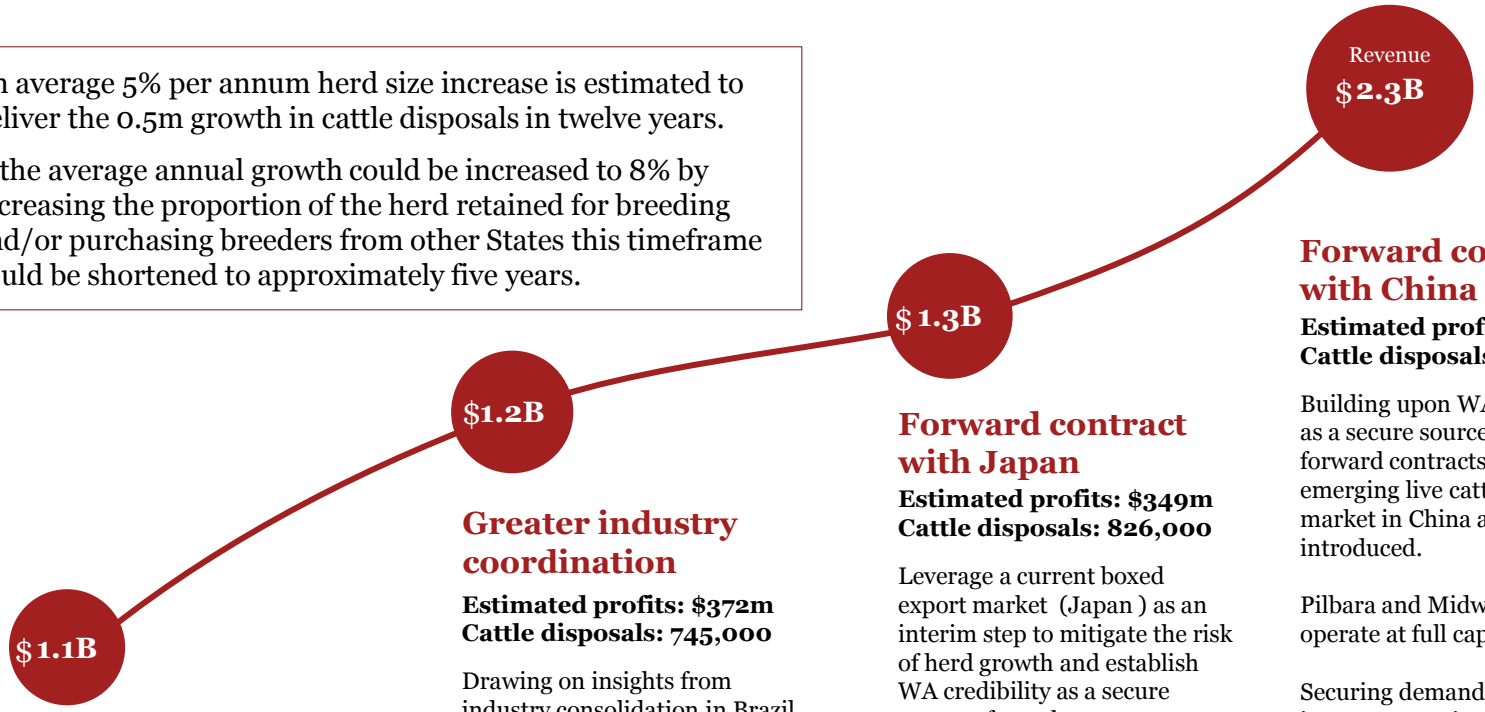
Note 1: See Appendix B for more result details

Note 2: Throughput 'head' is defined as the heads of cattle that pass through a value chain component in a year. Throughput 'rate' is the total head that pass through a value chain component as a percentage of its total estimated capacity

3.8 Results overview

Results indicate that, over a five to twelve year timeframe, the WA Beef industry might have the potential to grow cattle disposals, double revenue to $1.2B in increase profit by $0.5B.

- An average 5% per annum herd size increase is estimated to deliver the 0.5m growth in cattle disposals in twelve years.
- If the average annual growth could be increased to 8% by increasing the proportion of the herd retained for breeding and/or purchasing breeders from other States this timeframe could be shortened to approximately five years.



2015 Baseline

Estimated profits: $276m
Cattle disposals: 677,000

Based on 2015 production data.

Greater industry coordination

Estimated profits: $372m
Cattle disposals: 745,000

Drawing on insights from industry consolidation in Brazil, we model the impact of a more coordinated supply chain.

The increase in profits comes from leveraging domestic sales to support an increase to the herd size.

Production volumes are restricted by the current abattoir capacity of 438,000 head per annum.

Forward contract with Japan

Estimated profits: $349m
Cattle disposals: 826,000

Leverage a current boxed export market (Japan) as an interim step to mitigate the risk of herd growth and establish WA credibility as a secure source of supply.

Profit falls as premium grade meat is diverted to Japan and away from a higher priced domestic market, which is now supplied with standard grade meat.

Securing demand will require investment to increase abattoir capacity by 70,000 head per annum.

Forward contract with China

Estimated profits: $671m
Cattle disposals: 1.2m

Building upon WA credibility as a secure source of supply forward contracts with an emerging live cattle export market in China are introduced.

Pilbara and Midwest farms operate at full capacity.

Securing demand will require investment to increase feedlot capacity to be able to cope with 116,000 head at any one time.

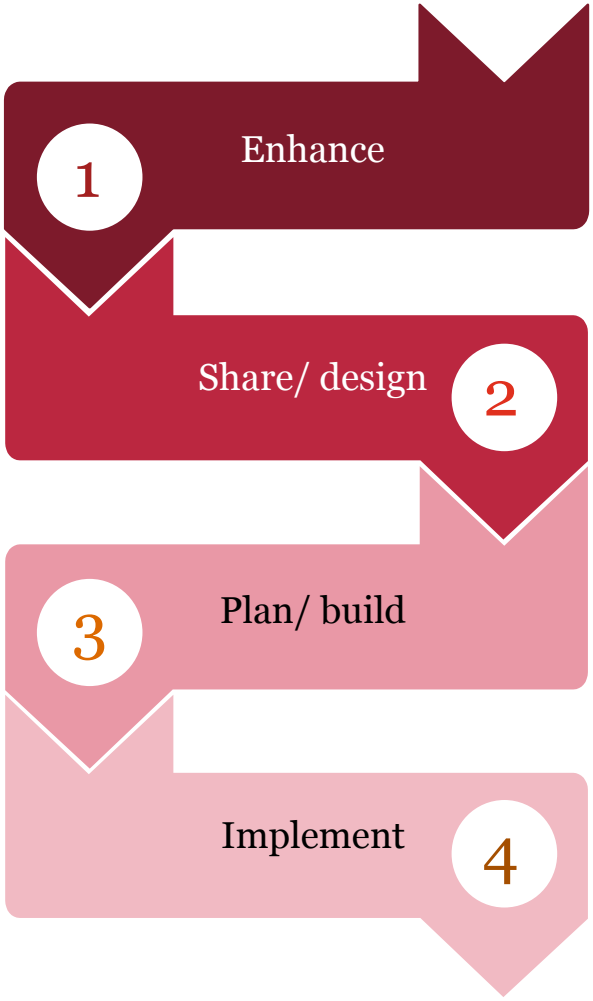
3.9 Market and product distribution

A diversified market which includes Japan and China growth is achieved by first halving exports, including those to Indonesia and Vietnam, and diverting them to the domestic market.

Sales destination	Baseline analysis	Scenario 1: Greater coordination	Scenario 2: Japan forward contract	Scenario 3: China forward contract
Domestic	Boxed: 67,477 tonnes	Boxed: 135,179 tonnes	Boxed: 135,179 tonnes	Boxed: 135,179 tonnes
Export: Indonesia	Boxed: 6,745 tonnes	Boxed: 3,373 tonnes	Boxed: 3,373 tonnes	Boxed: 3,373 tonnes
	Live: 67,273 head	Live: 33,637 head	Live: 33,637 head	Live: 33,637 head
Export: Vietnam	Live: 72,033 head	Live: 36,016 head	Live: 36,016 head	Live: 30,016 head
Export: Japan	Boxed: 7,195 tonnes	Boxed: 3,598 tonnes	Boxed: 25,000 tonnes	Boxed: 25,000 tonnes
Export: China	Live: 0 head	Live: 0 head	Live: 0 head	Live: 400,000 head
Cattle disposals	***677,000 head***	***744,900 head***	***824,300 head***	***1,225,135 head***

4 Potential road map

A structured industry-wide co-creative approach will be required if the full value of the security of supply is to be achieved.



- Consider and incorporate other DAFWA-NBF project outputs.
- Select group of relevant and representative stakeholders and present findings, establish appetite for industry growth, enhance data accuracy and agree next steps.
- Develop a stakeholder engagement and communication plan.

- Widen industry consultation, present findings, establish appetite for industry growth, enhance data accuracy and agree next steps.
- Assess regulatory criteria required to increase volumes in export markets.
- Model incremental volumes and estimate required returns.
- Hold discussions with selected potential investors and Japanese and Chinese customers.

- Design operating model.
- Develop a detailed implementation plan.
- Establish WA Beef industry governance structure.
- Establish team to develop business case.
- Obtain business case approval.
- Secure funding.

- Establish project team and governance structure.
- Execute implementation plan to realise benefits.

5 Disclaimer

This report has been prepared The Department of Agriculture and Food Northern Beef Futures project (DAFWA-NBF) for the purpose set out in contract number DAFWA375, dated 26 August 2016, titled "Western Australia Beef Industry Analysis – Valuing security of supply" and is not designed to be used for any other purpose. We do not accept any responsibility for losses occasioned to the DAFWA-NBF or to any other party as a result of the circulation, reproduction or use of our final or draft report contrary to the provisions of this paragraph.

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Appendices

A	**Modelling details**
B	**Model scenarios and results**
C	**Case studies and stakeholder insights**

A. Modelling details

Model development platform

Enterprise Optimizer models are built using five basic components.

Purchase

Purchase objects

Purchase objects allow the introduction of new materials such as cattle or feed into the supply chain.
Example features/constraints: Unit costs; Minimum number of units; Maximum number of units

Inventory

Inventory objects

Inventory objects represent the storage points of cattle or other materials, once they have been through a conversion process. These do not necessarily reflect a physical storage location in reality.
Example features/constraints: Collection points Carry forward units

Conversion

Conversion objects

Conversion objects combine input to produce a new output e.g, Abattoirs, transport hubs, feeding processes
Example features/constraints: Units costs; process rates; processing capacity

Sales

Sales objects

Sales objects represent the final point of the supply chain where the sales take place.
Example features/constraints: Price per unit; Minimum units for sale; Maximum units for sale

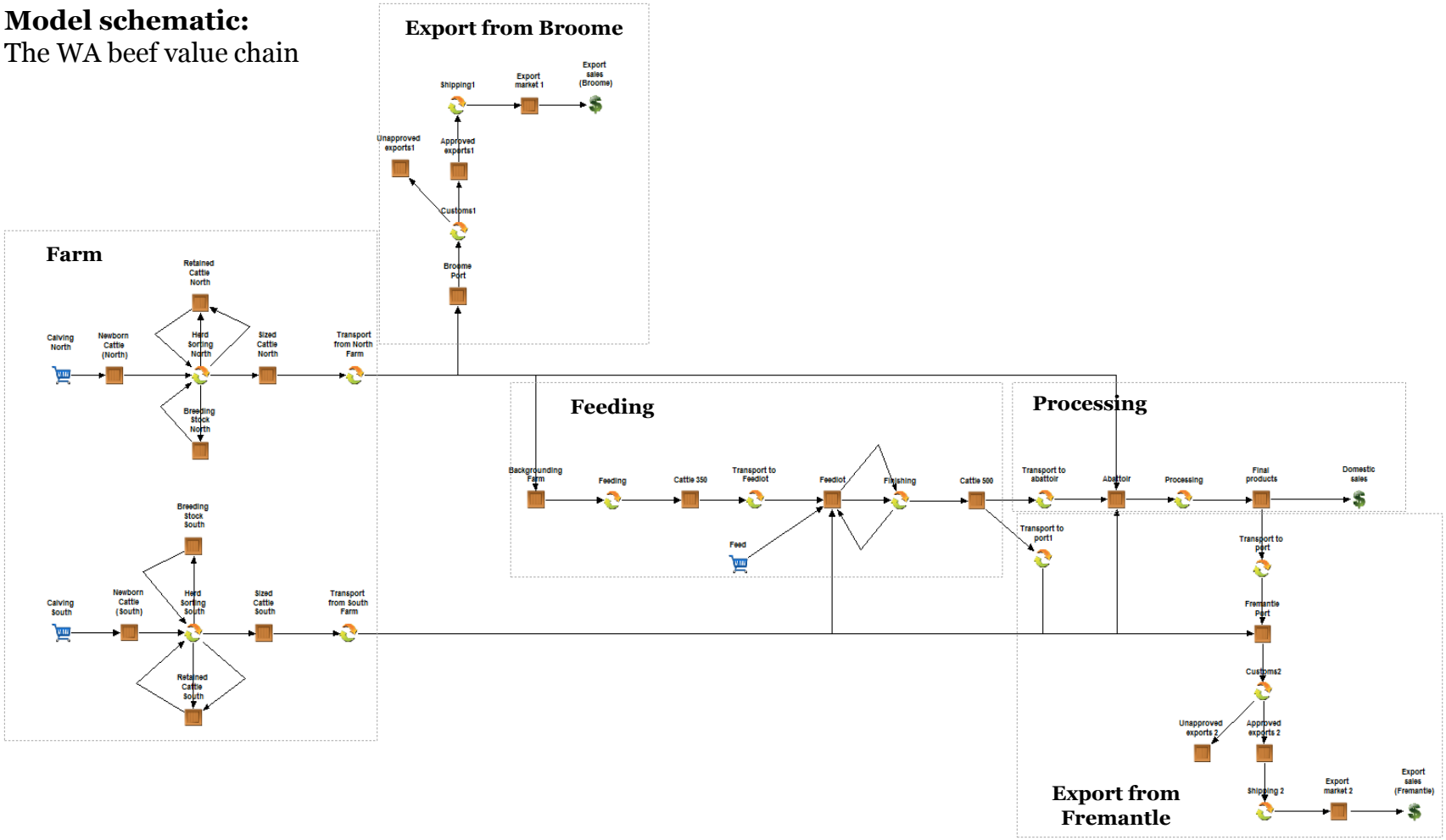
Sorting arrows

Sorting arrows represents the yield or distribution, and processes undertaken to move materials from one point to another.
Factor/Constraints include: transit time and costs; yields and distributions between conversion to inventory.

Model structure

Data and inputs are modelled in tables associated with each supply chain element.

Model schematic:
The WA beef value chain



Model variables

Variables in the beef supply chain model fall into five categories. Each variable is also either a fixed variable or a choice variable.

Model variables	Fixed Variables	Choice variables
Volumes		• Herd size • Cattle disposals • Export demand • Domestic demand
Capacities	• Farm capacity • Backgrounding farm capacity • Port capacity	• Feedlot capacity • Abattoir capacity • Shipping capacity
Costs and Prices	• Breeding cost • Processing cost at abattoirs • Transport cost • Shipping cost • Cost of feed	• Export prices • Domestic prices
Distribution	• Proportion of cattle retained for breeding • Distribution of cattle weights at muster periods • Distribution of steers and heifers at birth • Proportion of cows in the herd • Percentage yield of carcass weight at processing	• Distribution of herd between farms
Rates and Processes	• Growth rate of cattle at farm, backgrounding farm and feedlot • Seasonal constraints on processes	

Farm data inputs (1 of 3)

1. Cattle disposals

Cattle disposals (2015)	677,000 head

2. Farm capacity and herd distribution

Location	Capacity	Herd distribution
Kimberley Farm	706,000	36%
Pilbara Farm	345,000	10%
Midwest Farm	237,000	24%
Southwest Farm	655,000	30%

3. Herd composition

Location	Cattle breed	Distribution of type	Kept for breeding %
Kimberley Farm	Bos Indicus steer	51%	0
	Bos Indicus heifer	49%	75%
Pilbara Farm	Bos Indicus steer	51%	0
	Bos Indicus heifer	49%	75%
Midwest Farm	Bos Taurus steer	51%	0
	Bos Taurus heifer	49%	0.4%
Southwest Farm	Bos Taurus steer	51%	0
	Bos Taurus heifer	49%	0.4%

1. Disposal cattle are animals that enter the supply chain to be sold as live exports or be processed and sold as boxed beef. In 2015, this figure was 677,000 head from WA. In the scenarios analysed during this project. cattle disposals are not constrained to this number.
2. Farm capacity shows how many head of cattle each region (Kimberley, Pilbara, Midwest and Southwest) can carry at a time. This capacity is assumed to be fixed and cannot be changed in scenarios.
3. The herd distribution shows the distribution of cattle across these farm regions e.g. 36% of all WA cattle came from the Kimberley farm in 2015. This distribution can be changed in scenarios to allow a greater throughput rate.
4. The herd composition represents a realistic distribution between steers and heifers and is assumed to be fixed in all scenarios. The percentage kept for breeding shows the proportion of heifers each farm region generally retains for breeding to maintain herd size. This is also assumed to be fixed between scenarios.

Farm data inputs (2 of 3)

4. Weight distribution at muster

Regions	Weight category	Distribution
Northern farms (Bos Indicus)	Size 1: <150 kg	1.5%
	Size 2: 150 – 250 kg	31.5%
	Size 3: 250 – 300 kg	32%
	Size 4: 300 – 350 kg	23%
	Size 6: 400 – 450 kg	12%
Southern farms (Bos Taurus)	Size 4: <350 kg	12%
	Size 5: 350 – 400 kg	48%
	Size 6: 400 – 450 kg	34%
	Size 7: 450 – 500 kg	5%

5. Farm to next destination

Farm regions	Weaned cattle weight (kg)	Next destination
Northern farms	<150	Retain on farm
	150-250	Backgrounding farm
	250-300	Backgrounding farm
		Broome port
	300-350	Backgrounding farm
		Broome port
	400-450	Abattoir
		Broome port
Southern farms	<350	Retain on farm
	350-400	Feedlot
	400-450	Feedlot
		Abattoir
	450-500	Abattoir
		Fremantle Port

4. There are a total of seven weight categories for calves at farm at muster in the model. It is assumed that the northern farms carry Bos Indicus calves that fall within five of these weight categories, while the southern farms carry Bos Taurus calves in four weight categories. Bos Indicus calves have a lower average weight than Bos Taurus calves. A normal distribution of weights at the first muster is assumed in the model.

5. There are multiple options for moving cattle from each farm depending on the size of the cattle at muster. Cattle retained on farm through being too small in size become a bigger size in the following year and leave the farm. In the model, disposal cattle includes all the cattle that leave the farm to become live export or slaughter cattle in that year.

See pages 50-51 for process maps of cattle movement from northern and southern farms.

Farm data inputs (3 of 3)

6. Transport costs

Origin	Destination	Distance (km)	Cost per km	Capacity per truck	Cost per cattle
Kimberley Farm	Broome Port	1,043	7.20	210	$36
Kimberley Farm	Backgrounding Farm	2,968	7.20	210	$102
Kimberley Farm	Feedlot	3,289	7.20	210	$113
Pilbara Farm	Broome Port	1,000	7.20	210	$34
Pilbara Farm	Backgrounding Farm	1,009	7.20	210	$35
Pilbara Farm	Feedlot	1,327	7.20	210	$45
Midwest Farm	Feedlot	504	5.40	140	$19
Midwest Farm	Abattoir	528	5.40	140	$20
Midwest Farm	Fremantle Port	405	5.53	140	$16
Southwest Farm	Feedlot	164	6.85	140	$8
Southwest Farm	Abattoir	164	6.85	140	$8
Southwest Farm	Fremantle Port	282	6.36	140	$13

7. Breeding cost

Cattle breed	Cost per cattle
Bos Indicus (Northern farms)	$420
Bos Taurus (Southern farms)	$592.5

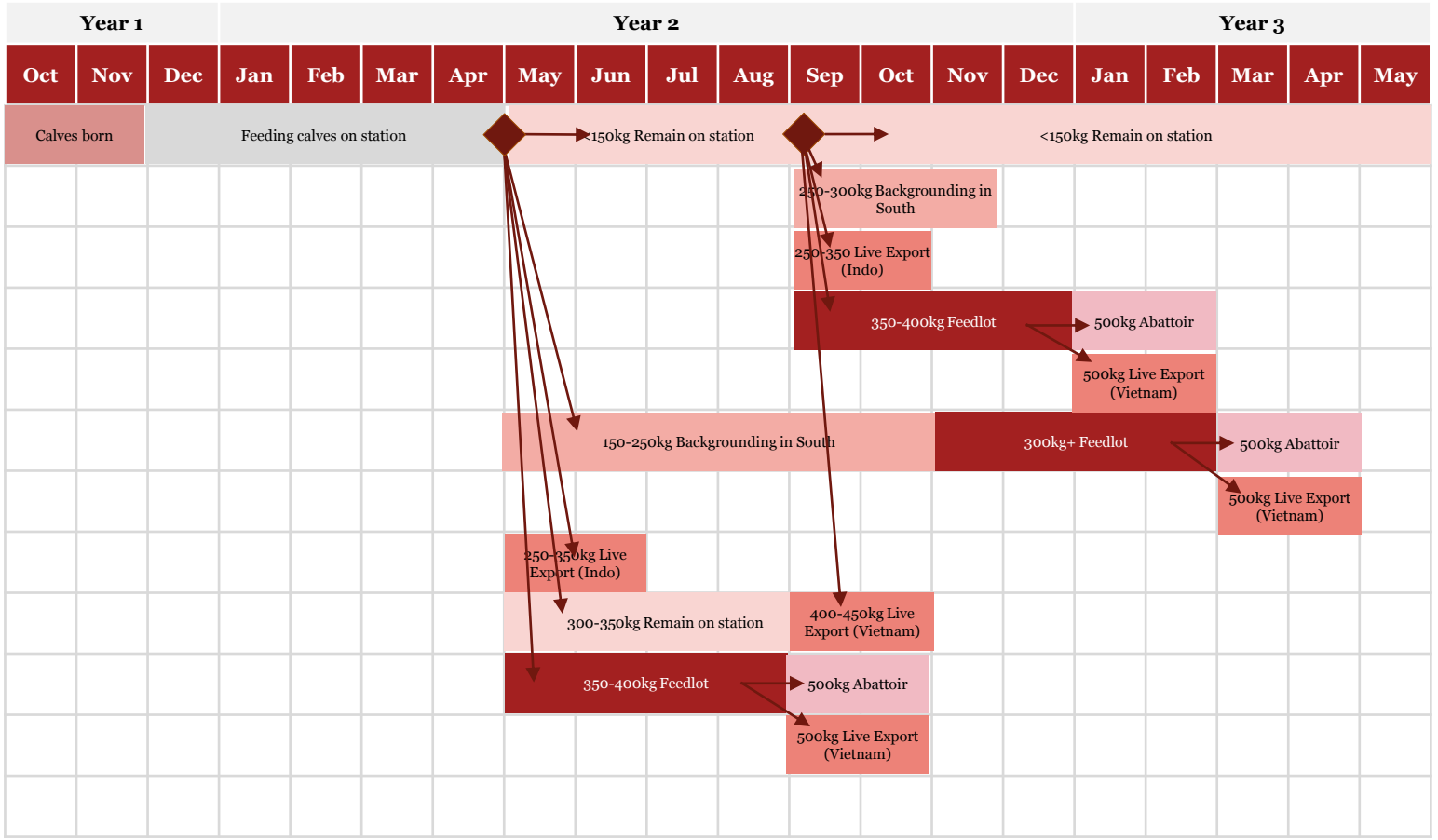
6. The transport cost is calculated by:
   - Average distance between each farm and cattle destination Average cost per km
   - The capacity of a truck that takes that route

   The cost per animal is calculated by dividing the total cost (distance x cost per km) by the truck capacity.

7. The cost of breeding is assumed to be the cost of feeding an animal from birth until it leaves the farm at a muster point. These costs are calculated assuming:
   - $1.5/kg weight gain
   - Average kg weight gain from birth until the calve leaves the farm

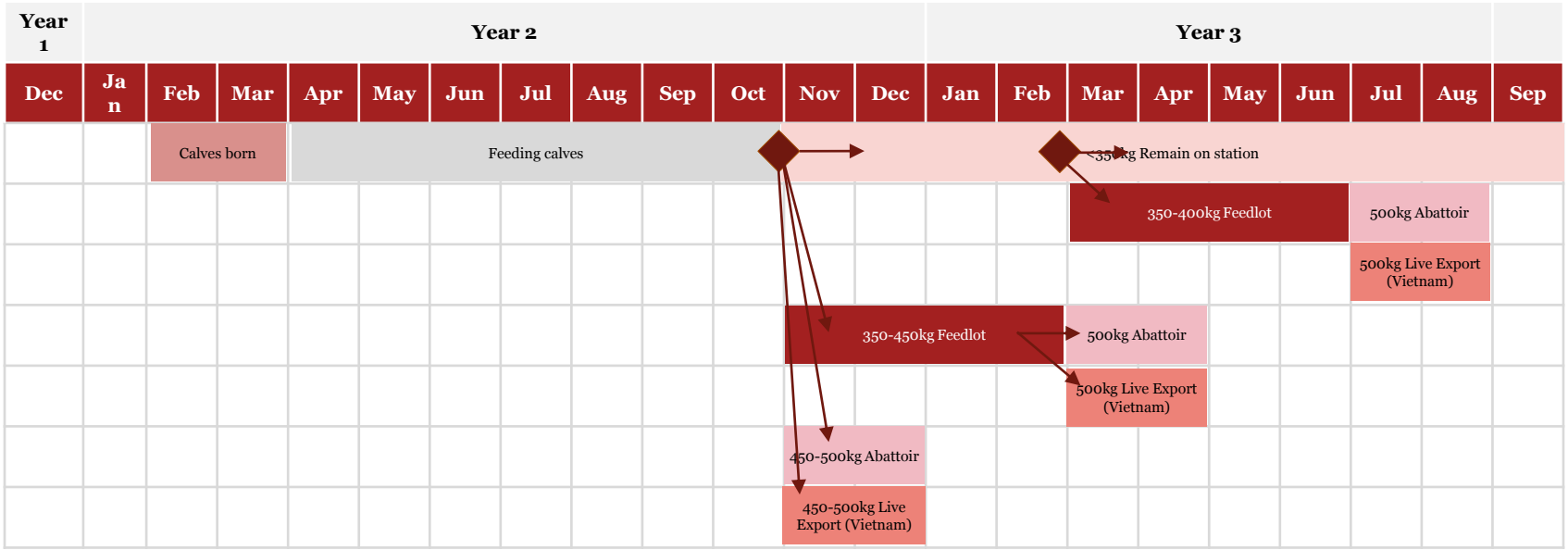
Northern farm process map

The model includes the processes of cattle from birth until it leaves the farm for slaughter or live export.



Southern farm process map

The model includes the processes of cattle from birth until it leaves the farm to for slaughter or live export.



Backgrounding farm data inputs

1. Rate of growth and cost

Cattle entry weight	Exit Weight	Average kg weight gain	Growth rate (kg/day)	Total days	Cost ($/day)	Cost ($/cattle)
150-250	350	150	0.6	250	0.3	75
250-300	350	75	0.6	125	0.3	37.5
300-350	350	25	0.6	42	0.3	12.5

2. Available months of feed

- May to November

3. Transport to feedlot

Origin	Destination	Distance (km)	Cost per km	Capacity per truck	Cost per cattle
Backgrounding Farm	Feedlot	107	8.02	140	$6

1. There are multiple variables modelled into the backgrounding process. The rate of growth is assumed to be 0.6kg/day for all cattle in the backgrounding farm. Cattle are in the backgrounding farm for different time period depending on their entry weight, resulting in a different cost for each animal.
2. The maximum duration and animal can spend on a backgrounding farm is constrained by the seasonal changes that dictate months of available feed.
3. The model assumes one backgrounding farm and one feedlot, which represents the aggregate for all WA facilities. Therefore the average distance between an associated backgrounding farm and a feedlot is used to calculate the cost for transporting a cattle.

   The transport cost is dependent on:

   - Average distance between a backgrounding farm and a feedlot
   - Average cost per km
   - The capacity of a truck that takes that route

   The cost per cattle is calculated by dividing the total cost (distance x cost per km) by the truck capacity.

Feedlot data inputs

1. Rate of growth

Cattle entry weight	Exit Weight	Average kg weight gain	Growth rate (kg/day)	Total days
350-400	500	125	1.6	78
400-450	500	75	1.6	47

2. Cost of feed

Tonne of feed per cattle per month	Cost per tonne	Cost per month
0.4	$450	$180

3. Feedlot Capacity

Feedlot capacity	115,000 head at a time

3. Transport from feedlot

Origin	Destination	Distance (km)	Cost per km	Capacity per truck	Cost per cattle
Feedlot	Fremantle Port	677	$5.29	140	26
Feedlot	Abattoir	693	$5.29	140	26

1. There are multiple variables modelled into the finishing process at the feedlots. The rate of growth is assumed to be 1.6kg/day for all cattle in the backgrounding farm. Cattle are in the feedlots for different time periods depending on their entry weight.

2. It is assumed that the cost per tonne of feed is $450 and that each animal eats 0.4 tonnes of feed per month to gain 1.6kg/day. This equates to a cost of $180 per head for every month that is it in the feedlot.

3. The feedlot capacity is assumed to be 115,000 head at a time. This means that if 115,000 cattle enter the feedlot at 350kg then the feedlot will be at full capacity for 3 months until the cattle reach the slaughter-ready weight of 500kg. This capacity is represents the aggregate capacity of all feedlots in WA.

4. Slaughter-ready cattle can either go to Fremantle port for live exports, or to the abattoir for processing. Transport cost is dependent on:

    - Average distance between a feedlot and the next destination
    - Average cost per km
    - The capacity of a truck that takes that route

    The cost per head is calculated by dividing the total cost (distance x cost per km) by the truck capacity.

Abattoir data inputs (1 of 2)

1. Processing cost

Cattle Type	Cattle weight	Cost per cattle
Bos Indicus / Bos Taurus	500	$265
Bos Indicus / Bos Taurus	400	$340
Cow	600	$265

2. Yield

Cattle Type	Cattle weight (kg)	Carcass weight (kg)	Yield (kg)
Bos Indicus / Bos Taurus	500	270	202.5
Bos Indicus / Bos Taurus	400	216	162
Cow	600	324	243

3. Final product mix

Final products	% of cattle
Offal	17%
Hide	12%
Blade	4%
Oyster blade	1%
Chuck	4%
Scotch fillet	2%
Skirt	1%
Porterhouse	2%
T-bone	4%
Rump	4%
Eye fillet	1%
Round	3%
Top side	5%
Silver side	6%
Osso bucco	2%
Shin beef	3%
Mince	19%
Sausage	9%

1. Processing cost depends on the weight of the cattle being processed. In general it is $265 per cattle, however cattle under 500 kg incur a penalty. Therefore, the cost of processing a 400kg animal is higher.
2. There is a general rule applied to the yield for all cattle. The carcass weight is 54% of the live weight, and yield is 75% of the carcass weight. These figures were used as they are the industry standard.
3. There are 18 final products built into the model. Each animal with the exception of cows, are processed into 18 products based on the percentages shown in the table. Cows are only processed into sausages.

Abattoir data inputs (2 of 2)

4. Abattoir capacity

Abattoir capacity	438,000 head

5. Transport to Fremantle Port

Origin	Destination	Distance (km)	Cost per km	Capacity per truck	Cost per tonne
Abattoir	Fremantle Port	170	$5.82	16.5 tonnes	$60

4. The abattoir capacity is 438,000 head a year which is the aggregate capacity of all WA abattoirs for domestic and export sales. This capacity is varied in scenarios to test the impacts of increasing abattoir capacity on the industry.

5. Boxed beef can be sold into domestic market or the export market through Fremantle Port. Domestic transport is not captured with the model.

   Transport cost is dependent on:

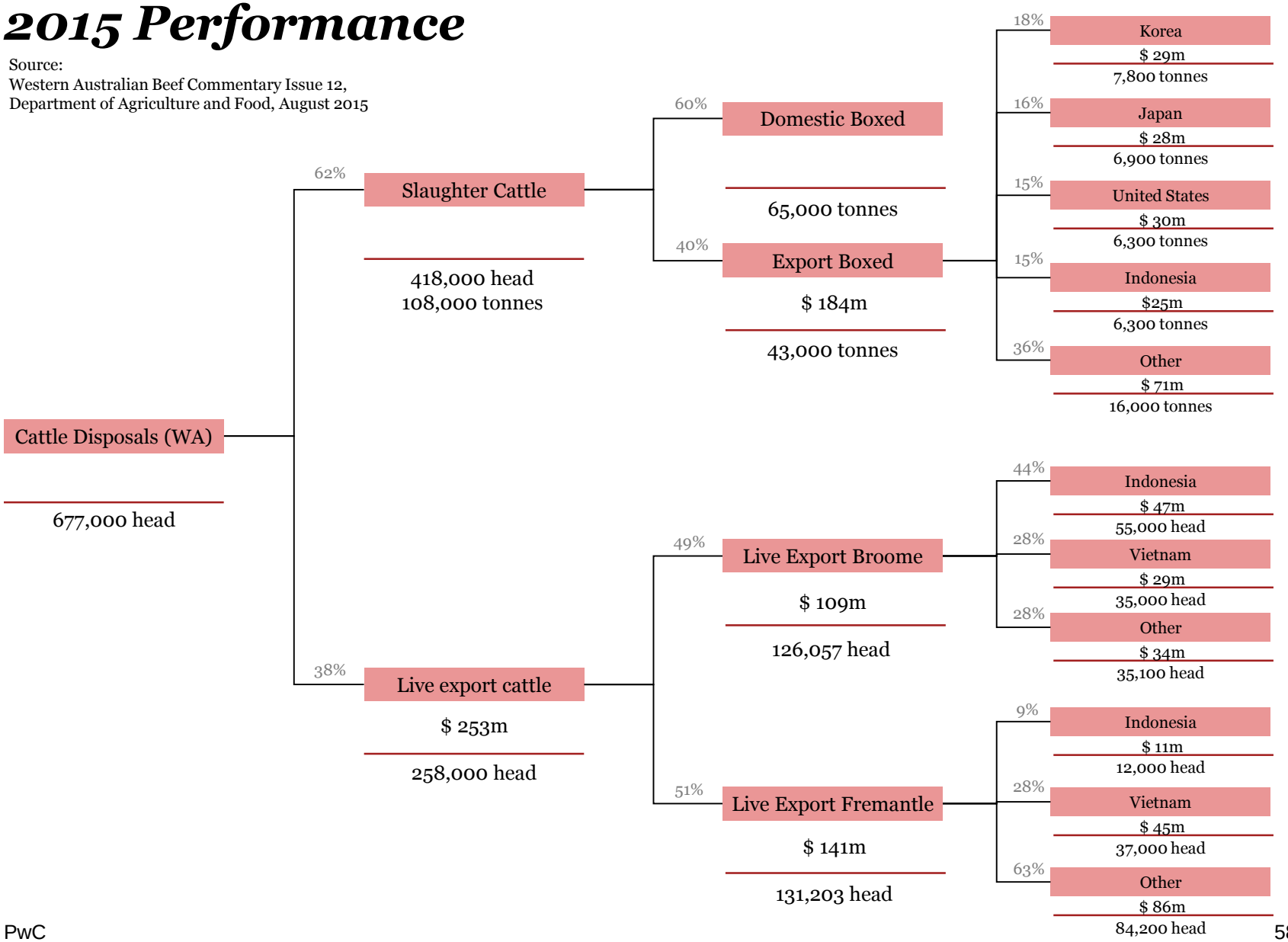
   - Average distance between abattoirs and Fremantle Port
   - Average cost per km
   - The capacity of a truck that takes that route

   The cost per tonne is calculated by dividing the total cost (distance x cost per km) by the truck capacity.

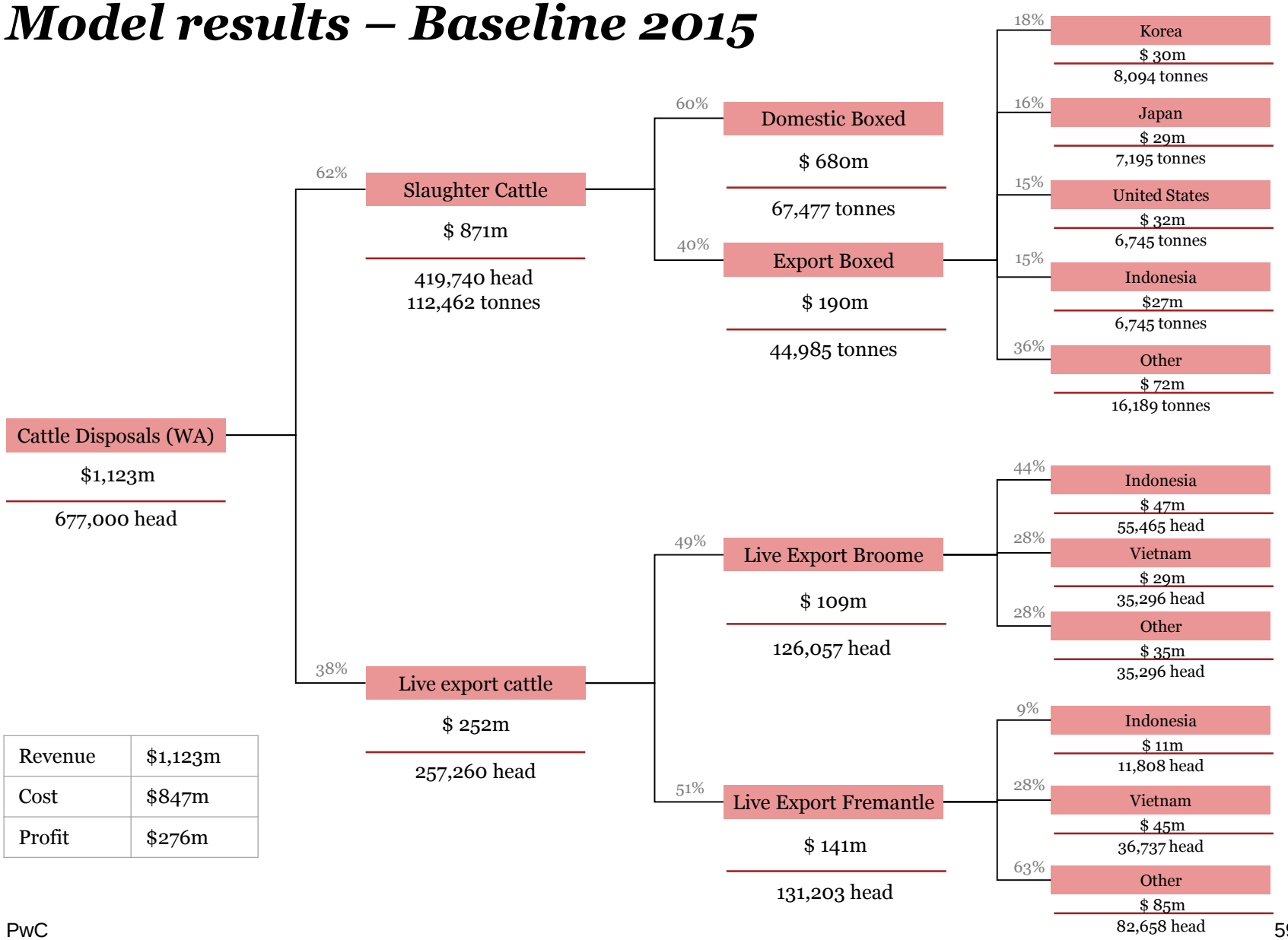
B. Model scenarios and results

2015 Performance

Source:
Western Australian Beef Commentary Issue 12,
Department of Agriculture and Food, August 2015

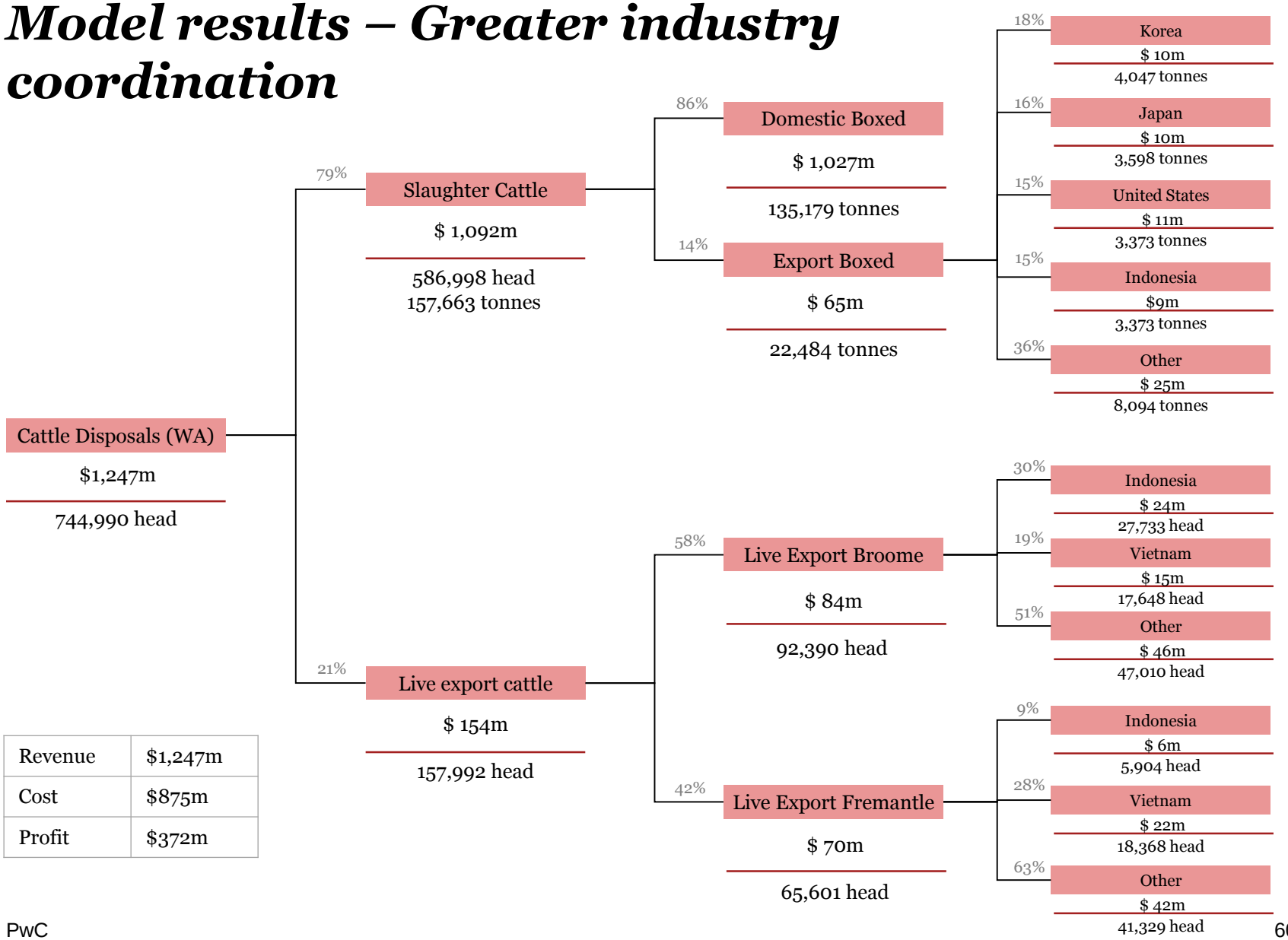


Model results – Baseline 2015



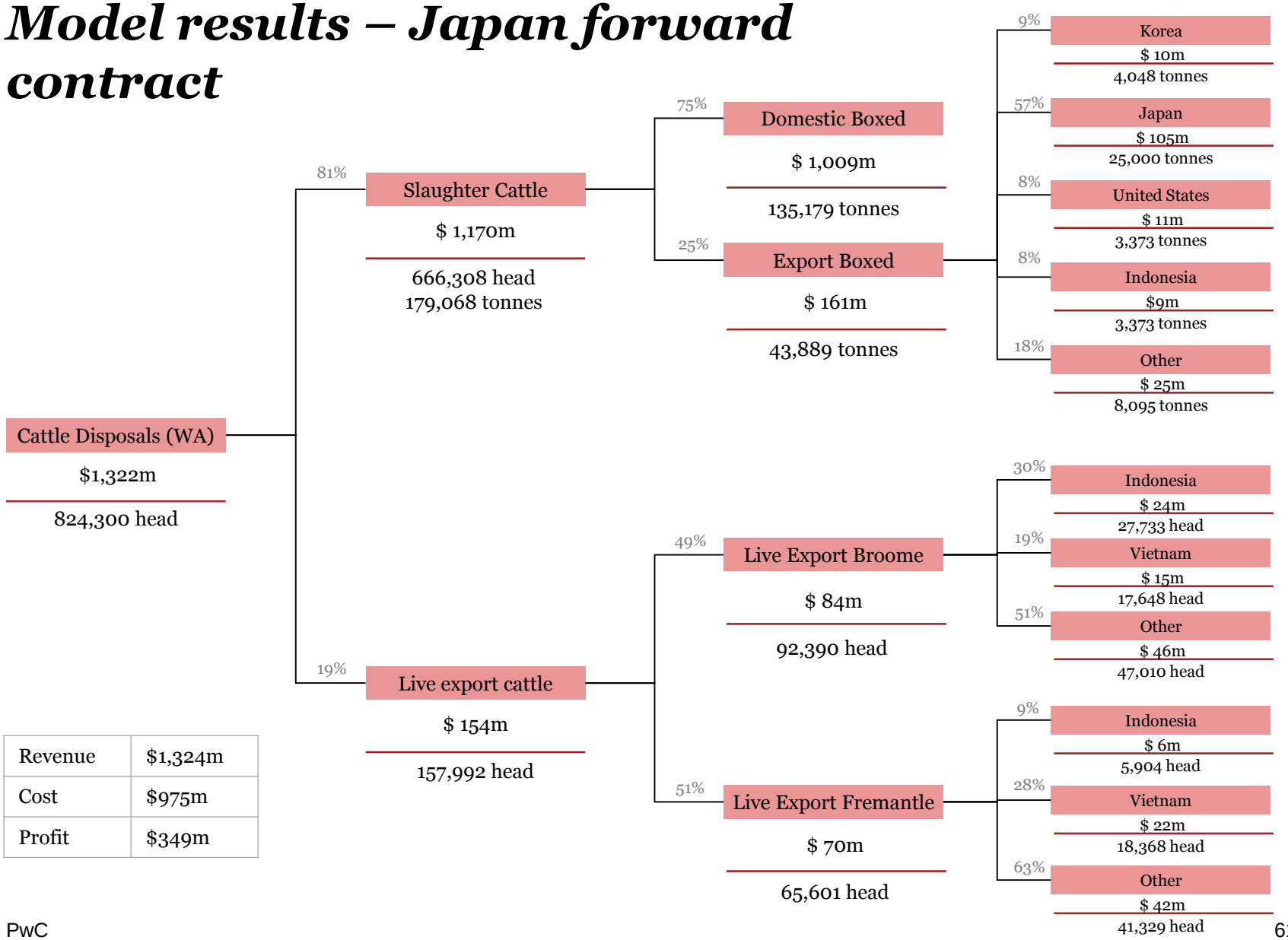
Revenue	$1,123m
Cost	$847m
Profit	$276m

Model results – Greater industry coordination



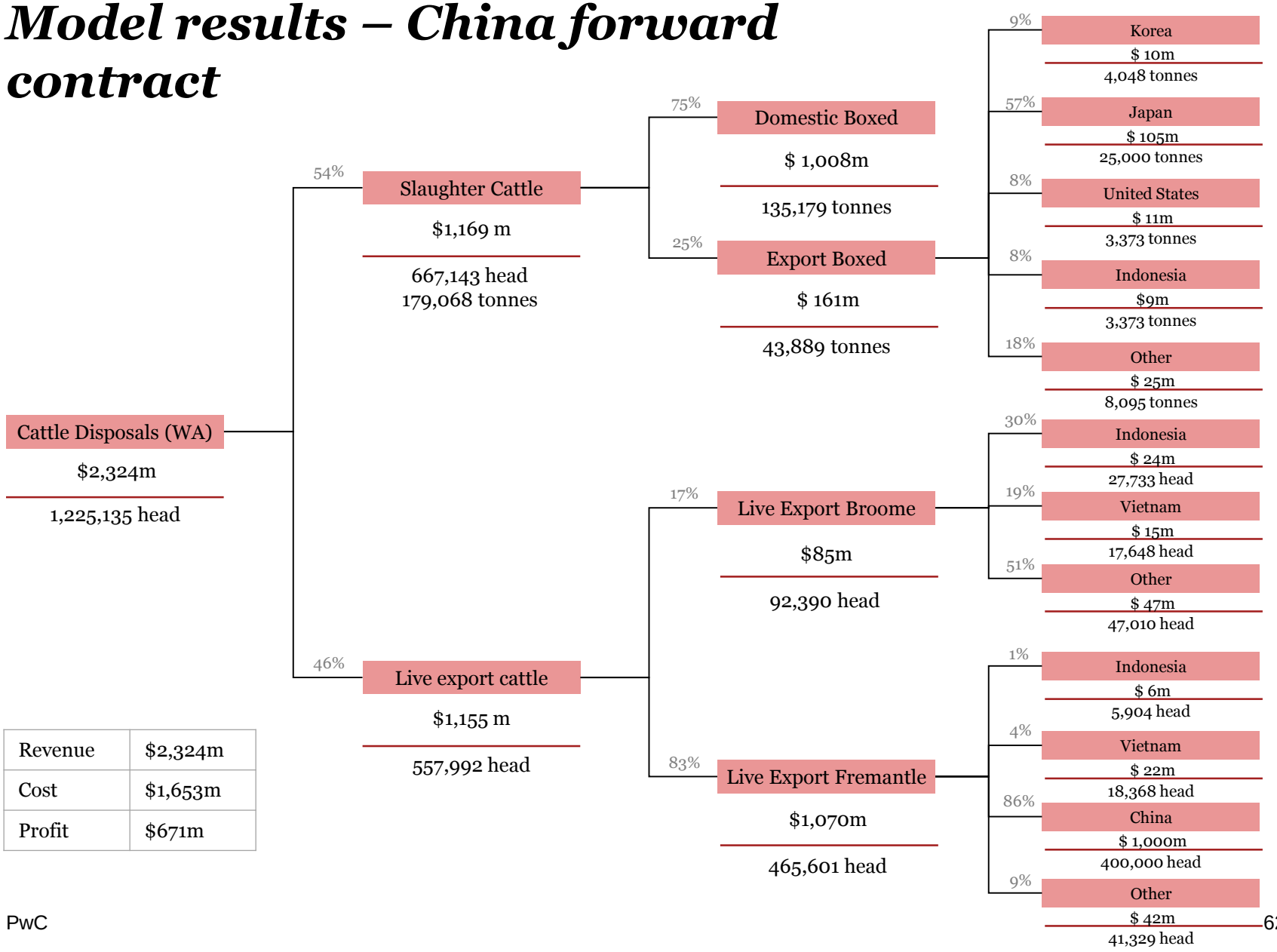
Revenue	$1,247m
Cost	$875m
Profit	$372m

Model results – Japan forward contract



Revenue	$1,324m
Cost	$975m
Profit	$349m

Model results – China forward contract



Revenue	$2,324m
Cost	$1,653m
Profit	$671m

C. Case studies and stakeholder insights

C1. Overview of scenarios and sources

C2. Greater coordination: insights from Brazil industry transformation

C3. Forward contracts: CME cattle futures

C4: Forward contract with China: China market overview

C5. China export competitor analysis: Brazil

C6. Feedback from World Meat industry development conference, Beijing, September 26-29, 2016

C1. Overview of scenarios and sources

Based on case studies and industry insights, scenarios are modelled in sequence, first raising capacity for secure supply, followed by measures to secure demand and increase production.

Modelling activity	Key evidence for the scenario
1. 2015 baseline: Using the results of the 2015 baseline model, we identify how the industry performed, potential improvements and potential sources of supply insecurity	• Analysis of the insight from the model using 2015 actuals • DAFWA-NBF supply chain research • Industry insight on key sources of insecurity
2. Greater industry coordination: Within defined parameters of industry behaviour, we model the assumed impact of better coordination across the WA industry to reduce disruption and take advantage of favourable market prices.	• Case study evidence of Brazilian industry transformation (page 65) • Industry insight from discussion with industry participants
3. Japan forward contract: Within the parameters of the Australia-Japan Economic Partnership Agreement (EPA), we test the feasibility of the large forward contract with Japanese importers as a means to securing demand.	• Chicago Mercantile Exchange cattle futures market (page 66) • Evaluation of MLA/SFE futures contracts • Conditions of the Australia/Japan EPA
4. China forward contract: We test the feasibility of a forward contracts with China as a means to securing demand for WA.	• Industry insight from world meat development conference (page 69) • China-Australia Free Trade Agreement

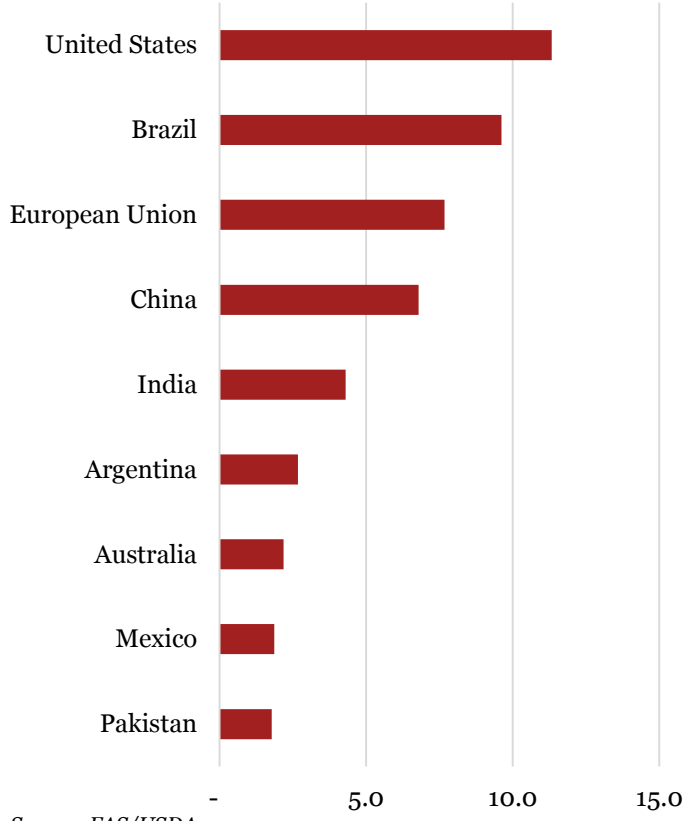
C2. Greater coordination: insights from Brazil

Brazil's beef industry overcame similar problems through consolidation over the last decade.

Key insights

- Beef production in Brazil has risen substantially during the last 20 years. During this period, exports have increased from 741,000 to 1,850,000 tonnes. The Brazilian herd size has grown by 30% between 1997 and 2009.
- Brazil's beef industry undertook extensive consolidation during this period. Brazil's largest agribusinesses expanded primarily through acquisitions. The large agribusiness JBS has acquired more than 50 companies in the last decade, and Minerva more than 8 in the last 10 years.
- These collective arrangements have enabled the industry to become well positioned in China, lifting the beef embargo.
- Brazil's development bank (BNDES) supported growth through the provision of subsidised finance and now owns substantial shares in the companies.
- For WA, government financial support on this scale unlikely to be forthcoming or a prudent option.
- However, the development of a broader, collective agreement between producers may extend the capacity to finance investment, and provide a single point of contact for negotiation.

Global beef production
2016, metric tonnes, million



Source: FAS/USDA

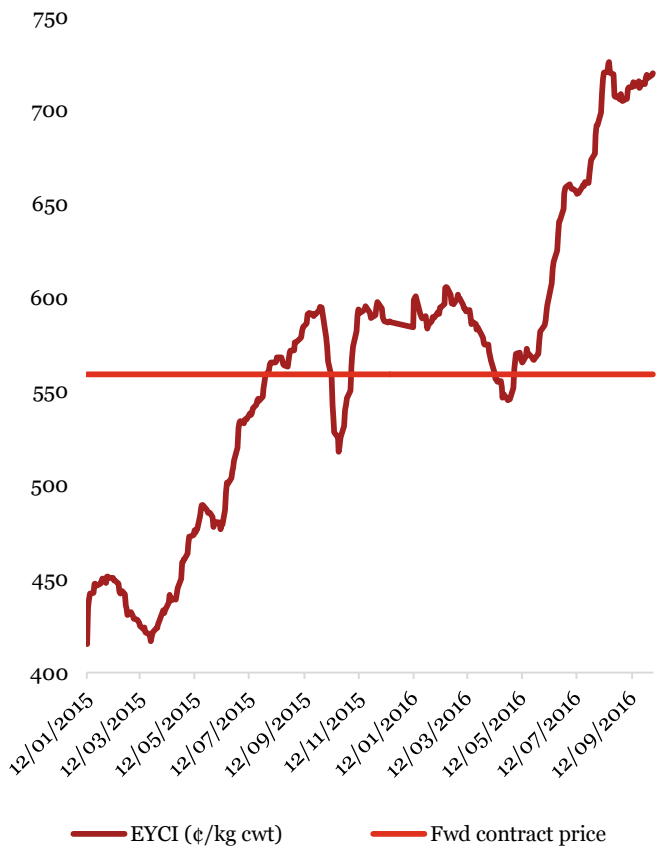
C3. Forward contracts: CME cattle futures

Forward contracts are used widely to secure demand and have demonstrated

Key insights

- Forward (or futures) contracts, such as those traded on the Chicago Mercantile Exchange reduce uncertainty and price volatility for by agreeing future prices, volumes and delivery dates.
- Beef "futures" contracts were introduced on to the Chicago Mercantile Exchange (CME) in 1964. Evidence suggests the ability to hedge against price movements and manage risk has been particularly welcomed by US farmers.
- In 2016, however the market has been characterised by significant price swings in prices. Anecdotal evidence suggests appears to have been due to the shortfalls in physical infrastructure.
- A similar system was setup by the MLA/SFE in 2002, but was brought to an end in 2009. Anecdotal evidence suggests risk management systems within the sector were insufficiently developed to make the contracts viable.
- Evidence indicates that forward contracting may be underutilised in WA. Contracts are made with domestic suppliers (often around 80 days) but are underutilised with importers in existing markets. Data indicate there is unlikely to be a sufficient number of participants to provide adequate liquidity for a complete market in WA.
- Taken together, greater industry coordination to manage risk and a more structured approach guaranteeing supply and prices with key markets that demand high quality beef such as Japan could create greater stability.

EYCI price and illustrative forward contract price
(based on 2015/16 average)



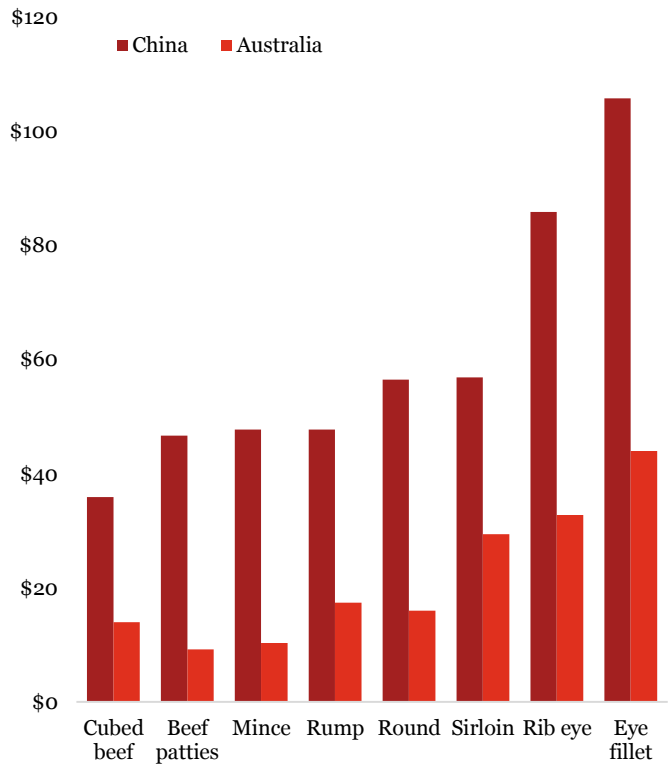
C4. China market overview

Chinese demand for beef is expected to continue growing, despite slowing economic growth

Key insights

- China is the worlds 4th largest beef consumer and demand for beef continues to grow, despite slowing economic growth. Despite maintaining the largest herd size in the world, the strength of demand for beef in China is illustrated by the sustained trade deficit China runs for bovine products.
- Industry research shows Chinese households predominantly use low quality beef for heavily seasoned dishes such hot pot, soups or stew. High quality beef tends to be purchased by hotels and restaurants, and those on higher incomes.
- High Chinese retail prices reflect demand exceeding supply domestically, with the retail cost of some cuts exceeding Australian prices by more than double.
- Industry insight suggests differentiating imported beef within the mainland is difficult given tight domestic regulations on labelling. As a result, Australia beef competes directly with lower cost producers, such as Brazil, on price.
- China has sought to diversify sources of imports to mitigate the price volatility in recent years. Brazil has overtaken Australia as China's main source of beef imports, and the US is due to re-enter the market.
- In light of this, the optimal strategy for WA producer may be to focus on live exports, provided large enough number can be shipped on a basis to meet AQSIQ regulations of 14 days limits.

Average retail price per kg
Australian dollars



Source: University of Queensland

C5. China export competitor analysis: Brazil

Macroeconomic factors coupled with industry coordination and underpin Brazil's improved export performance relative to Australia, but these are potentially passed their peak.

1. China's drive to diversify sourcing options

Lifting the ban on Brazilian beef and granting access to US suppliers reflects the authorities' strategy of diversification, designed to mitigate volatility in domestic prices.

2. Weak domestic demand in Brazil

Recession has reduced domestic demand for beef in Brazil. Falling domestic beef prices have encouraged producers to focus more on export markets.

3. Competitive exchange rate movements

The Brazilian Real has depreciated by 21% against the Chinese RMB in 2016. This decline has enhanced Brazil's low cost advantage; Brazilian production costs are already around 60% lower than their Australian equivalent.

4. Industry positioning to exploit trading opportunities

Brazil's largest agribusinesses have expanded the capacity and increased the number of abattoirs licensed to export to China over the past 12 months, in advance of the foot and mouth disease ban being lifted.

5. Australia's high domestic beef prices

Recent increases in domestic beef prices have contributed to the decline in the share of cattle produced for export, limiting volumes.

Insights for WA:

- Cyclical economic factors have been key to Brazils recent export growth. This is unlikely to be sustained in the long term.
- While government investment has been key to industry growth in Brazil, the financial problems facing Brazilian development lender BNDES, suggests this is risky strategy.
- Industry consolidation in Brazil is the key structural contributor to the step change in Brazils performance.
- In light of the unstructured, open source nature of the WA supply chain, there are likely to be considerable benefits from the greater integration, and the optimisation of production in WA.

C5. Feedback from the CIMIE conference

Feedback suggests significant appetite for investment in WA from Chinese investors

Agribusiness: Fulida

- Fulida is building the largest joint venture quarantine farm and abattoir in Hebei province to facilitate its livestock industry chain.
- They are interested in expanding access to the WA cattle supply chain.
- Domestic market focus in Beijing and Shanghai.

Processors: Fujian Anjoy

- Fujian Anjoy, one of the largest frozen food processor in China, plans to procure Australian meat product to supplement its brand name and product quality.
- They are interested in WA products with local partner as financial investor.

Financial institution: China construction bank

- China construction Bank has a portfolio of beef investments in China
- Officials expressed and interest in exploring investment opportunities in WA
- Portfolio diversification and securing the supply of beef are the key objectives.

E-commerce: Ali baba

- Ali Baba is the world's largest retailer
- It has an established domestic distribution network and capacity to expedite protocol clearance for imports.
- It has an existing meat distribution business, and can source meat from across the globe.

Retail/Wholesale: Hong Shun meat

- Hong Shun Meat co. Ltd. and Aufaly Food are wholesalers and retailers who are price sensitive due to industry fragmentation.
- They are keen to the establish a secure supply chain with WA, but remain very price sensitive.

Feedback from Chinese stakeholders so far has highlighted the following criteria to develop a viable long term secure supply model with China:

- **Guaranteed regulatory compliance.** Non-compliance, particularly with food safety standards can result in long term bans.
- **High quality imports need focussed marketing.** Imported boxed beef is not differentiated. Imports from Brazil, Uruguay and potentially the US will keep pressure on price. Australian beef occupies an increasingly niche market.
- **Competitive pricing is a priority.** Demand for high quality beef is limited, with high end hotels and restaurants increasingly price sensitive. Anecdotal evidence suggests profit margins have fallen from 20-30% 2 years ago to closer to 2-3% now.