final report

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The potential value of individual carcase identification and automated chiller sortation for an Australian lamb processor

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Executive summary

This scoping study estimates the potential value proposition for lamb processing plants by implementing automated carcase handling into and out of chillers using RFID traceability. Automatted carcase handling is not a new idea. However, existing sorting systems do not provide individual carcase traceability, nor do they provide the enabling platform required to utilise other existing technologies that can improve supply chain profit. The project provides capabilities in these areas that differentiate the project from previous carcase handling systems.
This preliminary scoping study indicates there is a return on investment in implementing the technology as proposed by the processor. The immediate benefits are in reducing costs to a processors business while reducing occupational health and safety risks, and enhancing traceability both up and down the supply chain. But as importantly, this proposal will provide a foundation for the industry on which to integrate other technologies that can provide additional significant benefits. These other technologies such as objective carcase grading independently provide returns but rely on individual carcase sorting and handling as proposed in this project to realise their true benefit. Combined, these benefits are significant for individual processors and the whole industry.

Investigating the potential of the technology in lamb processing plants is also relevant to the beef processing sector, and the beef industry as a whole. If this project is successful the resultant technology is readily transferable to the beef industry. Detailed figures for the beef industry were not investigated. However, given the size and weight of beef carcases, the OH&S risks and resultant costs will be higher in the beef industry so resultant benefits will also be greater than reported here.

Each area of benefit is reported in
Table 1 below as the “Potential Opportunity” but other limiting factors minimise the actual bottom line value that can be realised commercially. This “Realisable Opportunity” value has been considered and is the basis for all financial analysis in this report.

Area of Benefit **	Actual FTE's Saved	Potential Opportunity	Realisable Opportunity	$/Hd Opportunity	Wt'd $/Hd Opportunity	Small Stock Opportunity (18 M hd p.a.)
Boning Room Efficiency	1	$ 62,920	$ 31,460	$ 0.08	$ 0.04	$ 755,040
Labour Saving	5	$ 314,600	$ 314,600	$ 0.42	$ 0.42	$ 7,550,400
Consumables Cost Savings	1	$ 103,337	$ 103,337	$ 0.14	$ 0.14	$ 2,480,080
Boning Optimisation - Increased Carcase Value	0	$ 929,475	$ 371,325	$ 1.24	$ 0.50	$ 8,911,806
OH&S - reduced claims for back injuries	0	$ 33,381	$ 33,381	$ 0.04	$ 0.04	$ 801,139
Direct Yield Increase - Benefit to Processor	0	$ 337,303	$ 286,707	$ 0.45	$ 0.38	$ 6,880,979
Direct Yield Increase - Benefit to Producer	0	$ 269,842	$ 112,434	$ 0.36	$ 0.15	$ 2,698,423
Reduced Microbial Load - Improved Food safety	0	$ -	$ -	$ -	$ -	$ -
Quality - Reduction in Dark Cutters	0	$ -	$ -	$ -	$ -	$ -
		$ 2,050,858	**$ 1,253,244**	**$ 2.73**	**$ 1.67**	**$ 30,077,868**
Direct Benefits of Automatted Chiller Sorting	5	$ 451,317	$ 419,857	$ 0.60	$ 0.56	$ 10,076,579
Other technology benefits enabled by the project	2	$ 1,599,540	$ 833,387	$ 2.13	$ 1.11	$ 20,001,289
		$ 2,050,858	**$ 1,253,244**	**$ 2.73**	**$ 1.67**	**$ 30,077,868**

***FTE’s column reports the number of full time equivalent staff that will be saved.*
Each area of benefit is reported as the Potential Opportunity. In commercial situations other limiting factors minimise the actual bottom line value that can be realised. This realisable value has been considered and is the basis for all financial analysis in this report.

Table 1: Summary of benefits for a lamb plant processing 3000 head per day

Contents

1 Introduction

Investment by the processor to incorporate automated carcase movement within chillers, and automated carcase traceability will provide valuable outcomes in a number of ways. The details of these benefits and proposed method of integration at the plant are included in the processor's MDC application.

Greenleaf Enterprises has been engaged to assess the potential value of these technology components to the abattoir. It is intended that this report accompany the business modelling template prepared by Greenleaf Enterprises, which together are to supplement the MDC application by the Abattoir.

2 Purpose

This scoping study estimates the potential value proposition for lamb processing plants by implementing automated carcase handling into and out of chillers using RFID traceability.

The purpose of this report has been firstly to assess each of the benefits claimed by the processor and to identify any other potential benefits both to the lamb and beef industries; and secondly, to quantify the likely dollar value created by these benefits.

3 Background

The technologies within this project provide a platform to integrate a number of additional technologies now available to meat processors. Individually, these elements deliver some advantage for meat processors, however if implemented together, can add significant value to a meat processing business and the associated supply chain partners. It is foreseeable that technological advances and regulatory requirements for processing plants in the future will build on the platform provided by these primary technologies, namely the automated handling of carcases through the chillers, and automated carcase traceability using RFID. Without this platform, future developments will be limited.

This report incorporates the following elements:

1. Primary (enabling) technology components of the project;
a. Automated carcase movement for loading and unloading chillers
b. Automated carcase sorting for chilling and boning optimisation
c. Traceability of individual carcasses through the whole plant using hooks RFID devices,
2. Ancillary technologies made possible by the enabling technology
a. Objective carcase measurement
b. Yield/based payment system
c. Traceability through the supply chain
3. Outlining the potential application of this technology for the Australian beef industry;

4 Benefits and assumptions

The benefits yielding financial returns by implementing the RFID and automated carcase movement are summarised here and described in more detail below.

Generic	Annual ROI	Annual plant benefit	Pay back (months)	NPV
Net Benefit	12.6%	$ 1,113,244	15.1	$ 5,527,251

Daily production (hd)	3,000	Capital Cost	1,400,000
Avg carcase wt. (kg)	22	Useful Life	10
Lambs boned	90%	Discount rate	7%

Itemised Costs	Costs		
	$/head	$/kg	$ Annual
Total Costs	$ 0.19	$ 0.01	$ 140,000

Itemised Benefits	Benefits		
	$/head	$/kg	$ Annual
Automation (TOTAL)	**$ 0.60**	**$ 0.03**	**$ 451,317**
Labour saving	$ 0.42	$ 0.02	$ 314,600
OH&S saving	$ 0.04	$ 0.00	$ 33,381
Reduced micro counts	$ -	$ -	$ -
Boning room traceability	$ 0.09	$ 0.00	$ 69,587
Eliminating carcase tickets	$ 0.05	$ 0.00	$ 33,750
Optimised sorting of carcasses in chillers (TOTAL)	**$ 0.54**	**$ 0.02**	**$ 402,785**
Reduced chiller operating cost	$ -	$ -	$ -
Increased carcase value	$ 0.50	$ 0.02	$ 371,325
Increased boning efficiency	$ 0.04	$ 0.00	$ 31,460
Reduced chiller shrink	$ -	$ -	$ -
Reduced dark-cutters	$ -	$ -	$ -
Traceability (TOTAL)	**$ 0.53**	**$ 0.02**	**$ 399,142**
Feedback = ↑ yield = ↑ Processor profit	$ 0.38	$ 0.02	$ 286,707
Feedback = ↑ yield = ↑ Producer profit	$ 0.15	$ 0.01	$ 112,434
Total benefits	$ 1.67	$ 0.08	$ 1,253,244
TOTAL NET BENEFIT	$ 0.07		$ 1,113,244

Table 2: Summarised return on capital investment

4.1 Independent Mechanical Rail Control

Accumulating stepping chains will be provided for to enable loading and unloading of rails in any desired pattern. Each chain will be individually controlled so that the chain is in motion only when carcases are to be indexed along the rail thereby keeping energy requirements to a minimum. It will enable the loading and unloading pattern of carcases to be independent of each other according to boning room requirements.

4.1.1 Labour saving (4 full time equivalents)

The proposed systems individual rail control will completely automation chillers and remove all labour from the grading station through the chillers to the boning room.
Carcase sorting software will identify individual carcases by weight, grade and market category and will marshal carcases in variable configurations to meet orders. The first person after slaughter floor grading to come in contact with a carcase will be the pre-trimmer in the boning room.
This capability represents a total saving of 4 staff or $262,000 per annum.

4.1.2 Improved Occupational Health & Safety (equivalent of $0.04/carcase)

Removal of labour in chillers will eliminate workers compensation claims for back injuries resulting from sortation and management of carcases in and out of chillers. Victorian Work Cover Authority was able to provide very accurate data on injuries and OH&S claims resulting from specific injuries in the carcase sortation area for Victoria. These figures have been averaged over 6 years and converted to a per carcase cost. It has been assumed that injuries and claims will be similar in frequency and cost for lamb processors in the other states.
The saving in workers compensation claims is estimated to be $0.04/carcase.
AMIC provided similar figures for New South Wales and Queensland. However figures for the beef industry were not as easy to separate out for these specific areas of a processing plant. However, given the size and weight of beef carcases, the OH&S risks and resultant costs will be higher in the beef industry so the resultant benefits will also be greater.

4.1.3 Reduced microbial contamination (No dollar value due to lack of data)

Removing all carcase handling removes potential for cross contamination from hands and people rubbing up against carcases being pushed through chillers.
This reduction in cross-contamination although guaranteed, is difficult to place a value benefit on. Depending on other plant processes there may not be a noticeable difference in product shelf life. Given there is no scientific evidence available the benefit has been flagged as assisting in market access only.

4.1.4 Boning room traceability without carcase tags ($0.14/carcase)

The current practice in the lamb industry is to apply carcase tickets to all carcases for identification. This allows tracking of carcases loosely by lot until they get to the chillers. Then carcases are marshalled into loose carcase weight and market categories. At this point lots are mixed and the only tracking possible is by the carcase ticket in case of a recall.
Normal practice is to bring carcases into the boning room in production runs based on market category. Carcases are not normally scanned into the boning room so the level of traceability is reduced by another level of granularity. Product weights and efficiencies are reported by day. Traceability is by market batches and time stamps back to an approximate time period.
Market pressures and international retailer demands for increased traceability, integrated livestock supplier programs and minimisation of food safety risks are increasing. This sort of

traceability although possible through manual scanning of existing bar codes tickets does not occur.
The processor’s proposal to link carcase RFID with individual animal on the slaughter floor meets these increasing demands but removes some of the costs.
These cost savings include saving of carcase tags, half a labour unit to apply the carcase ticket and half a labour unit to scan the carcase ticket into the boning room, as well as the bar code scanner required for this job. The total savings are estimated at $105,800 per annum which is equivalent to $0.14/carcase).

4.2 Sorting of carcasses in chillers according to carcase measurements

4.2.1 Improved Chiller Management (Benefit not costed to $/carcase)

Opening and closing chiller doors and management of chiller hold and active blast cycles under current manual management are not as efficient as they could be. Automating management of chiller cycles becomes possible with the The processor’s proposal, resulting in some reduction in the cost of chilling. However, given the wide range in existing chiller infrastructure across Australian plants, an average industry benefit is too hard to quantify.

4.2.2 Improved Decision making on carcase fabrication ($0.50/carcase)

Previous detailed yield studies with lamb processors and in conjunction with Sheep CRC indicate current carcase sorting into market categories using GR score does not accurately measure the value of the boned out carcase. Further sorting of carcases using additional objective measures allow improved boning decisions. Most processors including those currently paying a premium for lean meat yield do not have the sorting capabilities within their chillers to benefit from the yield improvements.
The processor's proposal once proven provides a platform on which other processors can take immediate benefits from technologies they have already invested in but cannot fully extract the value from.
Detailed explanations of calculation assumptions are included in

Appendix 1 – Excerpt from Sheep Value Chain Study. This study was funded jointly by Sheep CRC and MLA to assess the commercial impact of carcase measurements on both the processor and the producer. The study was supported by a large yield data set and conducted in conjunction with a commercial lamb processor to ensure commercial robustness of the results.

4.2.3 Increased Boning Room Efficiency - sorting into similar boning runs ($0.04/carcase)

Current carcase grading broadly classes carcases into boning runs. Further sorting within existing classes using objective measurement systems would allow fatter carcases that require more trimming over the leg, shortloin and shoulder to be grouped together. Separating out the carcases requiring minimal trim will allow the boning room to be manned with less people in the areas mentioned to do other value-adding activities.
It has been assumed one staff position would be saved half the time ($0.04/carcase)

4.2.4 Reduced Chiller Shrink (No benefit to Ovine processors)

This potential benefit was considered due to previous work with management of chilling regimes in beef carcases where different carcase weight and fatness impacted on chilling times and resultant carcase shrink. Given the small variation in chilling requirements for lamb carcases, no benefit was identified.

4.2.5 Improve Meat Quality by Reducing Drafting During Lairage (No benefit yet)

Sorting of animals into lots prior to slaughter increases the risk of stress and dark cutting meat. Sorting mixed sale yard lots, or into runs based on market category can be required for both lamb and beef processors. Dark cutting in lambs although it does occur, is not as significant a problem as it is in the beef industry.
The The processor's proposal enables individual carcase traceability through the plant without a livestock RFID tag. Although this would allow mixed kill lots to be re-sorted or tracked to anywhere in the plant, it would require ear tag RFID's to eliminate sorting of mixed lots in the livestock pens. Live animal RFID tags not a part of this existing proposal and therefore a benefit has not been considered.
Beef on the other hand already have an NLIS RFID tag so any live animal sorting could be replaced with sorting into market categories post slaughter. For some beef plants this is estimated to save 1 labour unit and reduce dark cutting by approximately 15%.

4.3 Traceability back to Producer (Yield and Health)

4.3.1 Herd Health Traceability

The processor's plant IT system tracks all disease and herd health monitoring issues on an individual carcase basis. The release of this information will help producers in improving herd health and on farm production performance, as most information released to producers by processors is limited to weight and fat score. The key benefit of the proposed system is instantaneous identification of carcases at any point in the plant if disease outbreaks occur and need to be tracked. Smaller groups of carcases can be isolated without interruption of current processes. Product recall could involve less product due to exact tracking of time and location for every carcase in each step of the process.

4.3.2 Carcase Yield Traceability

Feedback to producers plays an important part in increasing efficiency and value of livestock production systems. Improvement in carcase composition and end customer value can increase significantly without additional cost as existing breeding programs are focused by more accurate carcase feedback. In the medium term global market forces will require this type of carcase feedback to enable faster improvements and to remain competitive. Improvement in production efficiencies in the pork and chicken industries has been significant and to a large part has been driven by accurate yield feedback.

Objective measurement systems provide individual carcase yield information to producers and have been implemented in the lamb and beef industries. But without the ability to sort and manage carcases into more specific boning specifications, extracting more value out of each carcase is not possible. For example, within an existing run of 22kg fat score 3 carcases; the difference in boneless shoulder yield is significant. Being able to further sort the rail of lambs into boneless for domestic and square cut for Mexico based on shoulder yield will increase per head profit, simply by further sorting.

The processor's proposal provides for an enabling technology that will be a minimum requirement for processors to extract this value in both the lamb and beef industries. Any company wanting to introduce more innovative supply chain initiatives with producers and customers in the future will need this type of carcase sorting and traceability to enhance their operations.

4.3.3 Identifying and Tracing Yield of Individual Carcases

Accurate measures of carcase yield allow more rapid improvement in carcase composition. The driver of this benefit is price incentives for higher value animals. Processors pay a premium for higher yielding animals but ensure the increase in value of yield is greater for their business than the premium paid. This makes the sharing of rewards sustainable over the longer term. Calculation and distribution of this benefit is explained in more detail in "

Appendix 1 – Excerpt from Sheep Value Chain Study" based on a real commercial case study. In summary the following benefits were identified:

- **Increased Processor Profit (Benefit of $0.45/carcase)**
- **Increased Producer Profit (Benefit of $0.36/carcase)**

4.4 Assumptions

Plant specific drivers

Production	Specifications	
Daily Throughput	3,000	hd
Weekly Throughput	15,000	hd
Weeks per year operating	50	
Value of LMY/kg (Avg Saleable value post trim)	$ 8.31	
Head killed per year	750,000	carcases
Average Carcase Weight	22	kg
Kilograms per year	16,500,000	kg

Labour	Specifications	
Job to Labour unit conversion factor (50hour week)	1	
Rate/h	$ 22.00	
Labour on-costs	43%	
Labour rate w/ On costs	$31.46	
Shift length	8.0	
Days per week	5	
Days per year	250	
Labour cost per FTE w/ On costs	$62,920	?????

Note that value of lean meat yield is the average saleable meat value after boning and trimming to a boneless specification and averaged across all cuts on the carcase.

4.5 References

Green P, Sweet T (2008) The Influence of Lamb Bone Out Yield on Carcase Profitability. For the Sheep CRC in conjunction with Meat and Livestock Australia, Sydney, Australia.

5 Appendix 1 – Excerpt from Sheep Value Chain Study

The following is an excerpt from a Supply Chain value study conducted as part of the Sheep CRC genetic improvement initiative. The title of the report was "The Influence of Lamb Bone out Yield on Carcase Profitability". It is included as supporting evidence behind the value benefits claimed in this report from sorting carcases more accurately for market value.

Genetic improvement in lean meat yield due to clear price signals - Longer term economic benefits

Abstract
Processors are forced to focus heavily on short term profit in response to ever changing market dynamics. Although improved carcase fabrication decisions using accurate yield measures are significant (estimated at $5.1M p.a. of realizable value), they are highly variable, dependant on short term market prices and product specifications. This variable ability to extract fabrication benefits in the boning room is probably one of the biggest factors preventing implementation of formal yield payment systems. However, increases in average carcase lean meat yield of the Australian flock over the longer term benefits all sectors of the lamb value chain. An increase in average flock lean meat yield of 0.42% per annum is estimated to be $5.4 M of realizable benefit to the total value chain.

Introduction
A number of meat supply chains around the world have installed measurement systems that accurately predict carcase composition and have paid producers based on some combination of factors including carcase lean meat yield. The Danish Meat Research Institute reported improvement in average pork carcase yield of 2.28% over a 10 year period and a Canadian pork supply chain also reported similar gains after installation of accurate yield measurement and reward systems.
The Australian lamb industry is a stark contrast with intensive pork production systems, however, current selection pressure for yield indicates improvements in LMY of 2% over 5 years is realistic. The objectives of this chapter are to:
Explain the very simple calculation of benefits resulting from an increase in the average LMY of the flock over time; and more importantly provide recommendations on how this type of system could be implemented, considering the commercial market pressures.

Methods
Response of the flock to selection pressure for improved yield was assumed at 0.41% increase per annum (p.a.). However, the exact improvement will not be known until value chains begin rewarding higher lean meat yields.

The value of lean meat was calculated at $8.31/kg by dividing individual carcase value by its LMY% and averaging across all carcases in the data set.
The formula for the calculation of total increase in value was:
$ Benefit of yield increase = % yield increase x Carcase weight x LMY $/kg

Results and Discussion

Total theoretic value of a yield improvement across the industry of 0.41% p.a. as in Table 5-1 is simple to calculate at $13.49 M ($0.75/carcase in Table 5-1) using the formula in Section 0.

Table 5-1 Calculation of net industry value for increasing flock lean meat yield

Annual Production (Lamb Carcases)		18,000,000	
Average value of LMY/kg (Sep 07-Apr 08 values)		$ 8.31	
Hot carcase weight/kg		22	
Allocation of Net Yield Benefit - Processor / Producer		Processor	Producer
		60%	40%
Lean Yield Improvement (LMY R^2 ~ 0.45)	LMY ↑ p.a.	$AUD	$AUD
Year 1	0.00%	$ -	$ -
Year 2	0.30%	$ 5,923,368	$ 3,948,912
Year 3	0.45%	$ 8,885,052	$ 5,923,368
Year 4	0.60%	$ 11,846,736	$ 7,897,824
Year 5	0.70%	$ 13,821,192	$ 9,214,128
Total Improvement	2.05%	$ 40,476,348	$ 26,984,232
Average Annual Improvement over 5 years	0.41%	$ 8,095,270	$ 5,396,846
Total Annual Industry Improvement / Head	$ 0.75		
Annual Improvement / Head (Processor & Producer)		$ 0.45	$ 0.30

In order to drive selection pressure, processors would need to pay a premium for higher LMY. The method for payment most acceptable to producers is a bonus system which is proposed in Table 5-1. Gross benefit from yield improvements is split 60:40 between the processor and the producer.

This system has significant merit for processors where supply is short and any mention of discounts results in shorter livestock supply. Conversely, a bonus for high yielding animals should encourage supply if communicated and structured effectively.

However, commercial implementation will prevent this full value from being captured. Not all carcases purchased will be boned out, in which case increases in yield will not impact the final carcase sales value. It was estimated in Table 5-2 that approximately 65% of carcases would be sold by processors in a form that captures the value of increased yield [this figure is very conservative with bone-out figures more realistically 85%]. However, consistent market signals to producers requires all carcases to be rewarded their relative LMY performance.

Table 5-2 Capture of lean meat yield gains along the value chain

Annual Improvement / Head (Processor & Producer)		$ 0.45	$ 0.30
Lamb processed further than bone in primal (*This indicates how much of the yield increase will result in realisable*		65%	100%
Realisable value of increased yield / head / p.a.		$ 0.29	$ 0.30
Realisable Annual Value to Industry		$ 10,658,772	

The net result for producers and processors is almost the same value.
Note the realisable value for processors ($0.29 per head / per annum) and producers ($0.30 per head / per annum) is an averaged across the total population.
Only a percentage of the carcases will be above a minimum threshold required to receive the LMY premium. The amount payable as an incentive to this smaller group of carcases is therefore much larger.
Based on the assumptions in Table 5-1 and Table 5-2, the premium payable has been calculated below in Table 5-3. Assuming the highest yielding 15% of the population receive a bonus premium, the amount the processor can afford to pay is $0.091/kg, while still receiving an equivalent benefit themselves of $0.089/kg.

Table 5-3 :Premium payable to high yielding carcases to give processor breakeven

Premium affordable		
Allocation of Net Yield Benefit - Processor / Producer	Processor	Producer
Realisable value of increased yield (TOTAL FLOCK) / head / p.a.	$ 0.29	$ 0.30
Percentage of livestock supply receiving premium	15.0%	
Breakeven increase payable (annual / carcase)	$ 1.95	$ 2.00
Breakeven increase payable (annual / Kg)	$ 0.089	$ 0.091

These assumptions do not take into account the cost of sourcing the genetics required to produce the yield increases, nor the additional administration costs incurred by the processor in managing the payment systems and in communication with producers.
It should also be noted that a program like this would take at least 2 breeding seasons before real increases in average herd LMY flowed through to the processor. Therefore the first tow years of such a system would be a cost to processors but a direct benefit to producers for existing herd performance.

Conclusion

How the Australian flock will respond to increased selection pressure for lean meat yield is not exactly known. However, isolated improvements to date and responses to selection for increased yield in other species indicate the rate of improvement will increase.
Processors would have to provide an incentive to producers to increase selection pressure. If long term improvement in yield is viewed in isolation from other yield benefits, the improvement needs to be self funding. Based on annual LMY improvements to the flock of 0.41%, processors could afford to pay a of $0.09/kg for carcases in the top 15% of carcase yields while receiving similar returns themselves. The gross benefit to the entire flock on an annual basis would be $10.6 M.

6 Appendix 2 – Excerpt from Sheep CRC Yield Value Chain Study

The following is an excerpt from a Supply Chain value study conducted as part of the Sheep CRC genetic improvement initiative. The title of the report was “The Influence of Lamb Bone Out Yield on Carcase Profitability”. It is included as supporting evidence behind the value benefits claimed in this report from sorting carcases more accurately for market value.

Using estimated lean meat yield to drive carcase fabrication decisions to maximize carcase value

Abstract

Lamb boning operations predominately sort carcases into customer cutting specifications based on GR depth and carcase weight alone. It is suggested that these minimal sorting standards focus more on gross volume of meat processed and limit the value realized for many carcases. This limited awareness of the true value potential of the carcase limits the return that can be shared along the value chain. Carcase value lost through less than optimal boning decisions is estimated at $0.28/hd on average for the Australian Lamb industry or $4,960,000 per annum. This lack of fabrication precision also limits clear market signals to producers about carcases that provide the best consumer value.

Introduction

Carcases with the same weight and fat score range are divided into different cutting specifications in order to sell the total volume. Contract prices and volumes have already been agreed so market price is not an issue at this point. The question now is whether splitting that group of same specification carcases further based on LMY will deliver more value than the current random sorting method?

The purpose of this section is to highlight the opportunities for optimizing carcase value through the boning process. Use of measurement technologies that accurately predict primal LMY enable more sophisticated sorting to optimize finished product value. This can be demonstrated for the leg, loin, and forequarter components separately.

The objectives for this section were to:

1. Identify carcase fabrication decisions that could improve total carcase profit in a commercial boning environment – Is there a value difference within current carcase grades?
2. Quantify the potential improvement in carcase value through use of decision processes in point 1.
3. Identify what portion of the potential value increase involves lean meat or saleable meat yield.

Methods

Adjustment to market prices

Identifying profit differences by sorting carcases differently into boneless and bone-in cutting specifications
The model helped identify a break-even price for each boning specification where half the primals were more profitable as bone-in and half more profitable as boneless. The primary focus was to identify those primals that were more profitable in boneless form, and then compare their carcase traits including LMY against primals that were still more profitable in a bone-in form.
The best cutting method for each carcase primal to give the highest customer value was identified in the data set.
The model then forced primals to be processed in the opposite way (bone-in became boneless and boneless became bone-in). The value difference between the two methods indicated the variation in customer value resulting from sorting carcases into different cutting specifications.

Results and Discussion

Realizing maximum value of the loin

In the saddle and shoulder all primal weights can be bone-in or boneless. This allowed the whole data set to be split half bone-in and half boneless to optimise carcase value, than alternate the fabrication methods for each half of the data set to determine the loss in value.

The following figure Figure 7-2 illustrates the limited correlation between the $ / kg value of loin primals when using carcase weight and the GR depth. Any type of sorting based on these measures is unlikely to be a benefit.
Further sorting based on lean meat yield measures is required to extract more carcase value. This requires more complex sorting of carcases based on LMY of legs, saddles and shoulders. Current chiller systems do not allow this type of sorting, even if objective measurement systems are installed.

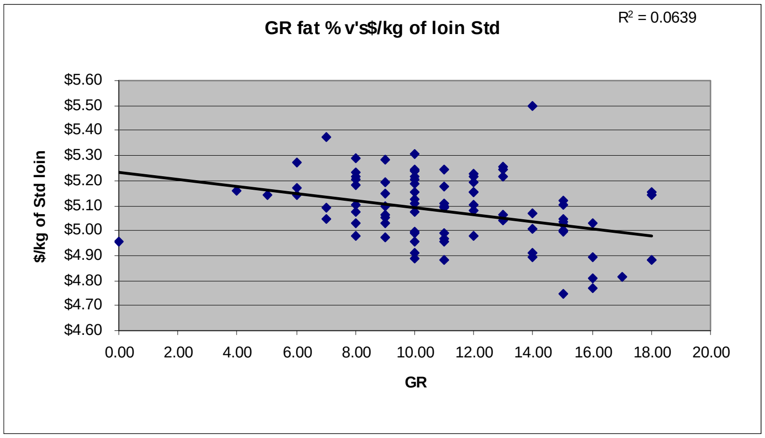

Figure 6-1: Scatter plot of Loin standard $ value /kg vs. GR Depth.

Further analysis was conducted for the 96 carcases for which all data was present (Table 6-1). Note half the data set of 200 samples was not supplied with boneless short loin data that allowed full comparisons in the middle primal. The results below limit the impact of yield on value prediction due to the smaller size of the data set.

1. Individual carcase value was assessed based on the market values boned three different ways (eye of short loin, USA rack and Loin standard).
2. This differentiated carcases with 50 being more valuable as whole loin standard as opposed to 46 being more valuable as boneless cuts. Results are shown in Table 6-1.
3. Loins that had the greatest value boneless had higher primal lean meat yields at 52.6% on average, as opposed to 48.89% lean in the standard bone-in loins.

Table 6-1: The effect of increasing the price of standard loin by $1.8/kg from $8 to $9.8/kg.

	Loins more valuable as Standard Whole Loin	**Loins more valuable as a combination of Boneless short loin + USA rack**
Number of carcases	50	46
Weight (kg)	21.067	21.57
GR depth (mm)	12.08	11.28
LMY (%)	54.24	56.34
% lean in loin	49.89	52.6
Value boneless ($/kg)	$5.97 /kg	$6.29 /kg
Value sold as whole loin bone-in ($/kg)	$5.83 /kg	$5.61 /kg

- In this Table 6-1 each of the last two rows represent two different ways of boning the entire population.
- The top row ( ) represents boned out cuts.
- The bottom row ( ) represents bone in primals.
- The Gold cells represent the most profitable way of sorting the total population into 2 different cutting specifications (boneless and bone-in).
- The Green cells represent the least profitable way of sorting into the same two cutting specifications.

The following costing (Table 7-5 - modelled on 10,000 head per week) was used to estimate the amount of value a plant could realistically expect to extract through better fabrication decisions in their boning room.

Table 6-2: Difference in commercial value of middles resulting from carcase fabrication decisions

	Loins more valuable as Standard Whole Loin	Loins more valuable as a combination of Boneless short loin + USA rack	5000 head	5000 head	
Combined value of split ($/kg)	$5.97 /kg	$6.29 /kg	$ 209,407	$ 226,103	$ 430,802
Value of Loin standard sold as whole loin bone-in ($/kg)	$5.83 /kg	$5.61 /kg	$ 204,699	$ 201,659	$ 411,066
				Weekly value difference between best and worst decision	$ 19,735
				Difference between Best and average decision	$ 9,867.75
				Predictive Accuracy of measurement device	0.47
				Difference that could be captured in plant	$ 4,637.84

1. Choosing to process the most optimum way in Table 6-1 with 46 highest value boneless loins at $6.29/kg and the remaining 50 as bone-in loins at $5.83/kg resulted in a total value of $430,802 in Table 6-2 across 10,000 carcases.
2. Alternatively, to sort and process the least optimum way with 46 head as Bone-in loins at $5.61/kg and the remaining 50 loins boneless at $5.97/kg would have resulted in a value of $411,066 across the 10,000 carcases

The total value difference of $19,735 in Table 6-2 explains the difference between the best possible sorting and the worst possible within a weight range. On average plants random sorting within weight range will pick up half this value variation. So the potential improvement will only be half the maximum variation, $9,867 in Table 6-2 in this case. The total value difference uses the real boning room yields so is reporting precisely what carcase yield differences were observed during the boning trials. Predictive accuracy of primal yields in commercial situations will be less than 100% so only a percentage of the value will be achievable. Because existing systems can only predict LMY at 47% accuracy the likely value to be extracted is only 47% of this at $4,637 in Table 6-2.

This equates to an opportunity cost of $0.46/saddle. At 33% of the total carcase weight this is $0.15/hd.

Note that market price variations have been removed. In reality the difference in value between the two options would be greater and the likely differences in value greater.

The benefit is highly dependent on the sales prices used for each of the different cuts. However, the sales prices in the model were adjusted to create as close to equal value of meat in both a bone-in and boneless form after accounting for cutting yield loss. Therefore the minimum difference in value between cutting decisions will be reported.

Factors driving value difference in forequarter

- Prices supplied by the plant for shoulder cuts indicated it was not profitable to bone out a shoulder for any carcases.
- We wanted to find a break-even price at which boneless shoulders should start being processed. The primary focus was to identify those shoulders that were more profitable in boneless form, and then compare their carcase traits including LMY against shoulders that were still more profitable in a bone-in form
- Sales price/kg was increased for boneless shoulder until some carcases became more profitable in boneless form. By increasing the price of a boneless square cut shoulder by 15%, 108 of the 200 lamb shoulders became more valuable as a boneless shoulder.
    - o Although sales prices were changed to eliminate the effect of market pricing on the model, this reduced the value difference of processor sorting decisions in Table 6-3 and Table 6-4 below.

- The average carcase weight was higher for the boneless shoulder group.
- These boneless shoulders also had a higher lean meat yield although there was almost no difference in total carcase lean meat yield (0.41% higher).
- GR tissue depth was higher in carcases that had a higher value boneless. This is in line with previous discussion on the low correlation between GR and carcase value.

Table 6-3: The effect of increasing the price of boneless square cut shoulder roast of $6 / kg by 15%

Parameter	Best $ value SQ cut shoulder BONE IN	Best $ value SQ cut shoulder BONE OUT
Number	*92*	*108*
% of population	46	54
Avg Bone IN ($/shldr)	$20.63	$20.89
Avg Bone OUT ($/shldr)	$19.19	$22.69
Avg $ value / head	$85.75	$92.17
Avg carcase weight	23.88	25.18
GR	15.11	17.98
% fat of total carcase	19.69	20.2
% Bone of total carcase	25.75	24.68
% lean meat yield for whole carcase	53.92	54.33
% lean in shoulder	**49.16**	**52.15**
Weight of forequarter	7.78	8.078
Forequarter as % of whole CCW	32.7	32.09

The same modelling methodology used in developing Table 6-1 was used to develop Table 7-7 below. This table shows the difference in value a plant could expect to extract through better sorting of carcases into bone-in and boneless boning runs when both types of products are being produced (modelled on 10,000 head per week).

Table 6-4: Difference in commercial value of shoulders resulting from fabrication decisions

Parameter	Best $ value SQ cut shoulder BONE IN	Best $ value SQ cut shoulder BONE OUT	5000 head	5000 head	
Avg Bone IN ($/shldr)	$20.63	$20.89	$ 103,150	$ 104,450	$ 200,400
Avg Bone OUT ($/shldr)	$19.19	$22.69	$ 95,950	$ 113,450	$ 216,600
			Weekly difference to plant		$ 16,200

Difference between Best and average decision	$ 8,100.00
Predictive Accuracy of measurement device	0.47
Difference that could be captured in plant	$ 3,807.00

The difference in value between high and low yielding carcases as bone-in primals was insignificant ($20.63 and $20.89). However, difference in primal value as boneless primals was highly significant at $3.50/shoulder ($22.69 - $19.19) or $0.46/kg of shoulder weight ($0.15/kg on a total carcase weight basis).

Conclusion

Changing fabrication specifications to optimise carcase value is only beneficial when customer orders for the highest priced product are less than total volume of raw material available. This allows selection of the highest yielding carcases for the more highly processed specification while the remaining carcases can fill the less processed specifications.

Loins and shoulders from carcases with similar GR depth and carcase weight can be further sorted on primal yield and processed differently to optimise primal value in the magnitude of $0.46/kg of loin primal and $0.38/kg of shoulder primal. This equates to approximately $0.14/kg of total carcase weight.

As leg primal weights increase, there is less ability for processors to optimise cutting specifications because all legs have to be processed boneless over a certain weight. However, yield becomes more important to customer value.