final report

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Commercial Evaluation and Viability of Lamb Water Frenching

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Executive Summary

Automated frenching systems have been available in the Australian lamb industry for a number of years but none of these systems can process for chilled sales due to limited shelf life. The McLaren iFrenching machine has been developed for both fresh and frozen product which has increased the application for automated frenching in Australian processing plants.

This review investigates the performance of the system in the commercial installation where it was tested and refined for Australian lamb carcases and customer specifications. A range of challenges were overcome during development which opens up new opportunities for processing racks for chilled export. Some of the opportunities achieved include:

- Reduction in labour cost for chilled frenched racks;
- Reduction in the number of repetitive strain injuries occurring in the boning room;
- Increased labour savings, as a result of frenching fresh product as well as frozen;
- Increased table space available for more slicers to complete other tasks and potentially increase room throughput;
- Better product presentation for foodservice customers

The McLaren iFrenching system is comprised of an in-feed conveyor and a high pressure water jet. The in-feed conveyor is set to the width of the racks and adjusted for the depth of the frenching line. This allows the operator to control the frenching length as required. The water jet has been established to push high pressure water through the intercostals removing all the meat to the required depth.

Substantial benefits could be achieved through the installation of a McLaren iFrenching system. The benefit identified in Table 1 are a result of labour savings and a reduction in the OH & S costs for the plant, the breakup of these savings can be seen in Figure 1.

Table 1: Summary of benefits observed over 1 and 2 shifts

SUMMARY PERFORMANCE MEASURES				
	Current		Current Throughtput w/ 2 shift	
Hd / annum	1,200,672		1,659,110	
Production increase with equipment	8.70%		8.70%	
	From	To	From	To
Capital cost (pmt option, upfront)	$500,000		$500,000	
Gross return Per head	$0.34	$0.32	$0.35	$0.33
Total costs Per head	$0.09		$0.09	
Net Benefit Per head	$0.25	$0.23	$0.26	$0.24
Annual Net Benefit for the plant	$301,581	$273,668	$435,497	$396,926
Annual Net Benefit for the ex cap	$293,393	$265,479	$433,159	$394,588
Pay back (years)	1.70	1.88	1.15	1.27
Net Present Value of investment	$1,969,359	$1,773,308	$3,107,066	$2,836,158

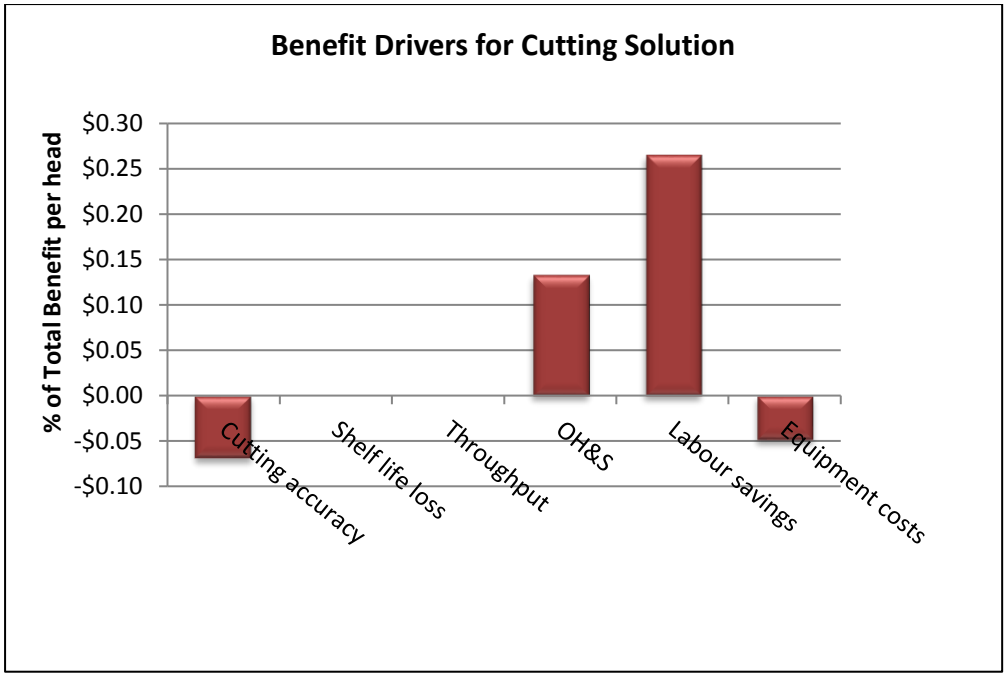

Figure 1: Detailed breakdown of benefits delivered by McLaren iFrenching machine.

Contents

1 Glossary

Term	Description
AQIS	Australia Quarantine & Inspection Service
CBA	Cost Benefit Analysis
Ex-ante	"*Before the event*". Ex-ante is used most commonly in the commercial world, where results of a particular action, or series of actions, are forecast in advance (or intended).
GMP	Good Manufacturing Practices
HSCW	Hot Standard Carcase Weight
MLA	Meat and Livestock Australia
McLaren	Stainless steel processing equipment manufacturer based in Hastings, New Zealand
OH & S	Occupational Health & Safety

2 Introduction

This project evaluates the McLaren iFrenching system for lamb racks. The prototype was developed in New Zealand and has been installed commercially in an Australian lamb processing plant.

Initial trials carried out in New Zealand determined the required modifications of the prototype to be made (based on product specifications supplied to equipment manufacturers) and verified in a pilot NZ trial before the adapted unit was shipped to Australia for commercial evaluation.

There are a number of potential technical and economic risks that had to be addressed in the research, for example, it is noted that some global markets (specifically European) of New Zealand processors significantly downgrade water cut products, and these potential impacts were evaluated.

Concerns about diminished shelf-life of water cut product was qualified in detail by CSIRO as a third part technical expert to oversee and report on the trials. In addition, Greenleaf has carried out commercial trials to evaluate the yield loss, quality of cutting lines and other potential technical and economic risks caused by the iFrenching system.

The results detailed throughout this report evaluate the commercially viability of the new equipment, cutting precision, ability to remove meat from the bone and sharpness of cutting. The modifications made to the prototype since its installation in an Australia meat processing plant have also been included in this report.

3 Objectives

The objectives of this ex-post study were to:

1. Measure the expected value opportunity of the McLaren's water iFrenching machine when compared against the manual cutting system.
2. Summarise the value benefit and main drivers for adoption of the equipment for Australian lamb processing.

The objectives of this project were successfully completed with the expected value opportunity and the main benefits for the installation of the iFrenching system are detailed in section 5.

4 Technology Description

The lamb iFrenching machine has been developed to french lamb racks without compromising the products chilled shelf life. This system is comprised of four main components described below.

4.1 Infeed conveyor

The in feed conveyor system feeds the rack into the system and ensures that there is no chance of the operator being injured by the water jet (Figure 2). This conveyor then feeds the rack through the system and exits the product to the outfeed conveyor.

Figure 2: In feed conveyor

4.2 Water Jet

The water jet (Figure 3) has been developed to inject high pressure water through the ribs of the rack to effectively remove the intercostal from the bone.
The length of intercostal to be removed can be modified through moving the height of the rack up and down.

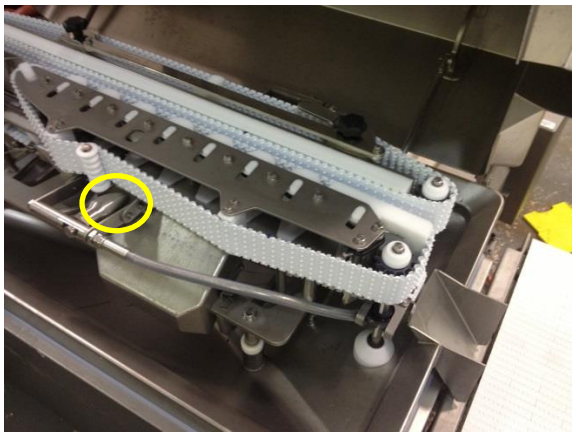

Figure 3: Water frenching jet (circled in yellow)

4.3 Out-feed conveyor

An out-feed conveyor (Figure 4) is not supplied with the system but needs to be adapted to the specific site needs in transferring frenched racks from the machine back into production flow.

Figure 4: Out feed conveyor

4.4 Water filtration

The water filtration system (Figure 5:Water filtration system) has to be installed to remove the organic matter from the water after it has exited the iFrenching system. The capacity of the filtration system will vary from plant to plant depending on the number of iFrenching systems required.

Figure 5:Water filtration system

5 Methodology

The main savings attributed to the installation of an iFrenching machine is associated with the reduction in labour requirement on the boning room floor. This system reduces the weight of product sold as intercostals and reduces the operational costs of the boning room. This section explains how the data was collected and analysed to quantify the costs and benefits associated with the installation of the iFrenching system.

5.1 Operating and OH&S Costs

The operational and OH&S data collected was as follows:

- Staffing levels per shift;
- Cost per hour for staff;
- OH&S claim costs over the last 10 years;
- Power, water and maintenance costs;

These costs have been used to calculate an average operating cost as a result of the installation of the McLaren iFrenching system.

5.2 Cutting Yields

The only yield affected through the installation of the iFrenching machine is a result of the lost weight of intercostal and bone. The value of loss in yield from the iFrenching system has only been applied to 41% of production. This is the proportion of racks frenched where the system has been installed. For plants frenching a higher proportion of racks please observe the variation per head costs in section 6.1.

The loss of intercostals during the water frenching process is caused by the high-pressure water denaturing the intercostal. A sample of product lost can be seen in Figure 6. The collection of information associated with the reduction in yield was conducted as follows:

- Measure the length of intercostal;
- Weigh each section of intercostal;
- Obtain the production data over a period of weeks, to identify the length and weight of intercostals lost;

Figure 6: Intercostal yield loss through water frenching

5.3 Product Saleability

5.3.1 Shelf life

Automatic frenching machines have traditionally been used on frozen racks. This is due to previous systems causing an increase in bacterial counts on fresh products thus reducing their shelf life. However, this system has been developed to be used on fresh products, through ensuring the shelf life is maintained on fresh product. During the development stages there were a number of modifications made to reduce the aerosols caused by the water jet.

There were a number of alterations made to the frenching process to reduce the water containing intercostal meat coming back in contact with other racks. The lifter meat is usually removed prior to frenching. To keep the finished loin meat as dry as possible the lifter meat was left on the racks during frenching and removed post processing. Figure 7 shows the lifter meat left on the rack prior to frenching. This has reduced the labour savings as they need to remove this prior to packaging, which required an additional slicer to be added to the line after the frenching systems.

Figure 7: frenched racks, Left rack still has the lifter meat left on it and the right rack has been trimmed ready for sale

There have also been a number of modifications made to the iFrenching machine and processing chain as follows:

- Changed the water jet to reduce the amount of water being used, and created a funnel to direct used water away from the racks which in turn reduced the aerosols contamination.
- Increased the rate at which the racks were chilled post frenching, which reduced the bacterial counts.

5.3.2 Product presentation

The presentation of the racks has been improved through the use of the iFrenching system. In most cases the customers receiving these products have also been able to reduce their staffing levels. This is a result of the rib bones being cleaner than when frenched manually, allowing foodservice customers to sell racks as they are received.

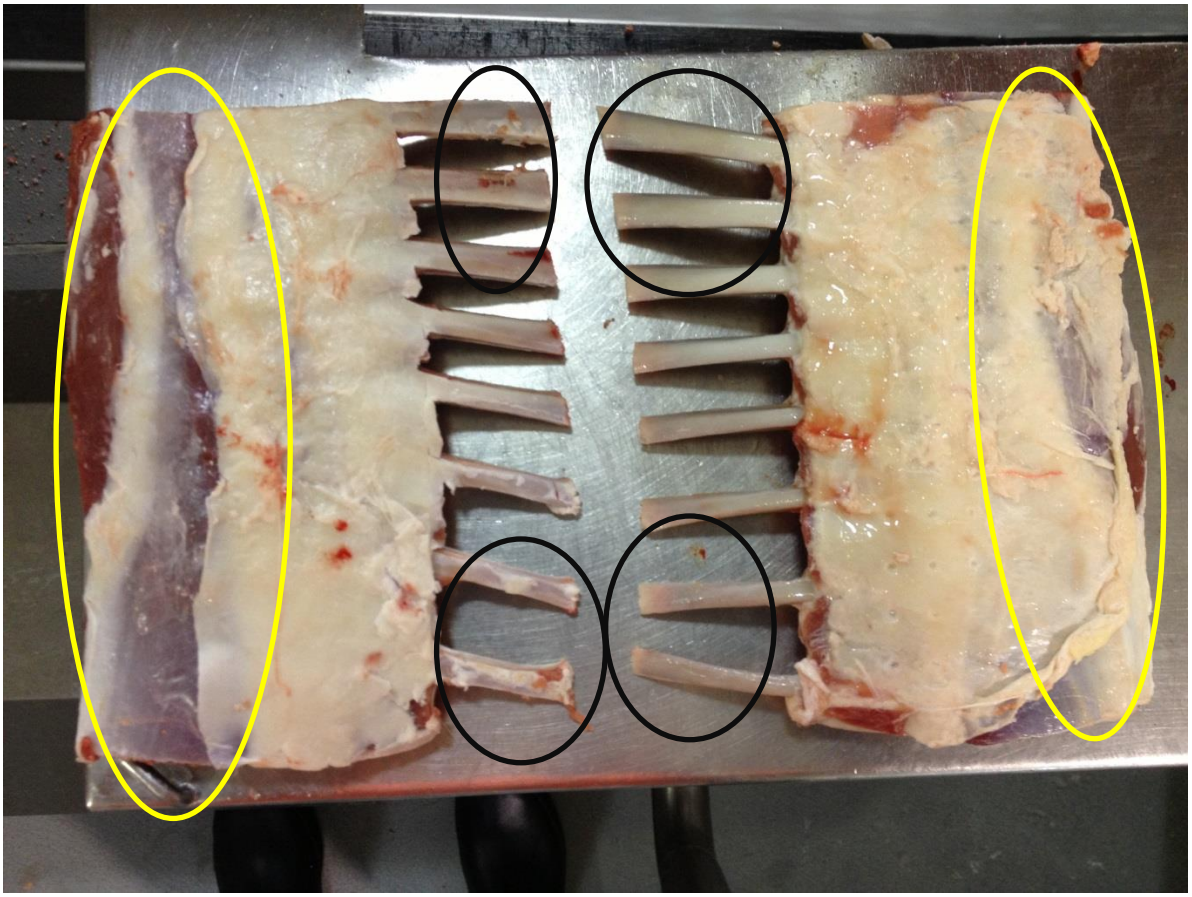

Figure 8: Effect of the iFrenching system on the presentation on the racks.

The two racks shown in Figure 8 are manually (left) and automatically (right) frenched racks. There are a number of presentation differences which can be seen in these shown by the yellow and black circles.

The yellow circles show the cap muscle is required to be left on the rack until after it has been frenched. This required an additional slicer to be added to remove the cap. The cap muscle has been left on the right hand side rack to reduce the water contamination to the eye muscle during frenching.

The black circles shown in Figure 8 demonstrate the improved appearance of the rib bones from the use of the iFrenching system. This is caused by the water jet being able to remove all the meat from the ribs bones when compared to the manually frenched racks.

5.3.3 Bone loss

The reduced weight in saleable bone as can be seen in Figure 9, is a result of the system breaking bones during the frenching process. This only occurs on a very small portion of the racks and is caused by the in feed conveyor stretching the ribs.

Figure 9: The yellow circle demonstrates the lost weight of saleable bone

Foodservice customers have commented that the water frenched product has superior presentation compared to manual frenching and is now the preferred product.

5.4 Statistical Analysis of Data Sets

There is always a range in accuracy and performance within manufacturing environments and particularly where a biological product like a carcase is involved. Manual processes will always show a range in variation as will automated process but hopefully to a lesser degree. This variation impacts on the level of value created or lost. The range in cost or benefit (reported as “From” and “To” represent the lower and upper range in value) is also of interest and has been included in the summary results of this report.

5.5 Fixed Model Drivers

To establish the dollar value per head of each of the costs and benefits, the following production numbers were used in Table 2. The table summarises the estimated performance for the manual operation as a base line and the ability of the automated system when compared to the manual process. Details for each of these scenarios are in sections 5.5.1, 5.5.2 and 5.5.3.

Table 2: Calculation used for determining production volume base line

Processing room operation speeds			
	Manual	Current	Current Throughtput w/ 2 shift
Carcases / min	7.58	7.58	7.58
Carcases / Statn./hr	455	455	455
Carcases / day	5003	5003	6913
Annual days	240	240	240
Annual # of hd	1,200,672	1,200,672	1,659,110

5.5.1 Manual Process

The current manual process of the room has the following specifications:

- 1 x 11hours shift per day;
- Processing 7.58 carcases per minute;

5.5.2 Automated process

This process is the same as the manual process except it removed 7 slicers from the boning room table as a result of the iFrenching system.

5.5.3 Automation with two shifts

This process is the same as the current process except the processing is being conducted over 2 x 7.6 hours shifts. This demonstrates the possible future expansion in capacity of the processing line.

6 Results and Discussion

The main cost benefits to the installation of the iFrenching system are as follows:

- Reduction in work cover premiums;
- Increased operational costs;
- Increased in labour productivity;
- Decreased labour requirements;
- Decreased saleable intercostal yield;

The cost savings will be discussed in detail in the following section.

6.1 Cutting Accuracy Loss

Table 3 shows the variation in loss of intercostal yield due to the installation of an iFrenching system for plants processing a high and low percentage of frenched products. The variation between these types of plants is $0.09/head processed which is attributed to the number of frenched products sold. The variation in yield losses will vary between plants and the times of the year.

Table 3: The variation in yield losses between plants which are frenching a high and a low proportion of racks

		Proportion Frenched			
		41%		85%	
Loss summary		$/hd From	$/hd To	$/hd From	$/hd To
1.1 Accuracy	Intercostals	$0.06	$0.08	$0.14	$0.19

6.2 Labour Savings

Table 4 shows the variation in the number of staff required for each position of the boning room with the installation of the iFrenching machine. As seen by this table there has been a reduction of 11 slicers (between 6 and 13 slicers) required to french racks and an increase in three staff per shift required as a result of the iFrenching system. Two of these additional staff are required to operate the iFrenching and the third is a slicer to remove the cap from

the rack after frenching. The estimated labour saving of $0.26/hd has been achieved through the installation of the iFrenching systems.

Table 4: Labour savings achieved with the installation of an iFrenching system.

Labour Savings per day			
	Number labour units required		
Task	Manual	Current	Current Throughtput w/ 2 shift
Supervisor	1	1	2
Band Saw operator	6	6	12
Trimmers	24	24	48
Packer	41	41	82
General Labor	3	5	10
Boners	12	12	24
Slicers	13	3	6
Total FTE's required	100	92	184
Total FTE's saved	-	8	16
Saving per head	$0.00	$0.26	$0.26

6.3 OH &S Issues

6.3.1 Amputations and Minor Cuts

There have been provisions made in the model to include the cost of amputations and minor cuts caused by frenching racks. The risk of an amputation caused by manual frenching has been included as zero, due to there being no reported incidences over the last 10 years.

6.3.2 Strains and Sprains

The introduction of the iFrenching system has reduced the strains and sprains that occur on the boning room floor. There have been the provisions for the iFrenching system to reduce the number of claims to 2 per year. This has been included due to reduced work requirements by the slicers.

6.3.3 OH & S Savings

Based on the assumptions above, the following frame work in Table 5 shows OH&S benefits. The estimated OH & S savings that can be achieved through the installation of the automated system is up to $0.13 per head.

Table 5: OH&S Benefits of automated x-ray primal cutting system

OH&S					
	Amputation	Sprain and Strain from lifting			
Job Role Affected	Slicers	14			
Claims in last 10 years	0.0	20.0	Manual	Current	Current Throughtput w/ 2 shift
Risk / FTE / Year	0.0%	80.0%			
Annual Premium		$20,000			
Job Annual Hours			34,320	7,920	10,944
Limb Losses per year			0	0	0
Sprains and Strains per year			10	2	2
Annual Cost			$208,000	$48,000	$48,000
Annual Cost / Head			$0.17	$0.04	$0.03
Annual saving per head			$0.00	$0.13	$0.14

6.4 Increased productivity

There has been a limited increase in productivity caused by the installation of the system. Although no increase in productivity has been counted in the model, provision has been made for an increase in room's capacity as there is now additional room on the boning room floor due to a reduction in the number of slicers required. The scenarios shown in Table 6 are explained below:

- The manual column is the base mark for all the comparisons to be made,
- The current column is the ex-post results for the system
- The current throughput with two shifts is the potential payback period if the plant moves to two 7.6 hour shifts per day.

Table 6: Manning of processing room

Increased throughput through the room			Manual	Current	Current Throughtput w/ 2 shift
Average daily hd			5003	5003	6913
Hd/annum			1,200,672	1,200,672	1,659,110
Average kg			21.88	21.88	21.88
Total Kg boned per day			109,461	109,461	151,256
Boning room cost / hour			$3,266	$3,266	$3,266
Boning room cost / day			$35,921	$35,921	$49,636
Labour cost \ per kg to bone			$0.33	$0.33	$0.33
Labour cost \ per hd to bone			$7.18	$7.18	$7.18
Labour productivity savings/ head			$0.00	$0.00	$0.00
Task	Rate / hour	WW Loading 35.00%	Number labour units per shift - Manual Process (Note - this is gross of labour savings - based on No. of Head above)		
Supervisor	$35.00	$47.25	1	1	1
QA	$31.00	$41.85	0	0	0
Band Saw operator	$26.23	$35.41	6	6	6
Trimmers	$23.10	$31.19	24	24	24
Packer	$23.10	$31.19	41	41	41
General Labor	$23.10	$31.19	3	3	3
Boners	$26.23	$35.41	12	12	12
Slicers	$26.23	$35.41	13	13	13
Total FTE's required			100	100	100

6.5 Operational costs

This section compares the costs of operating under manual conditions and using the iFrenching system.

6.5.1 Manual

There has been no reduction in manual operating costs as there was no equipment removed from the boning room.

6.5.2 Automated

Table 7 shows the total cost of the equipment Including both capital and operational costs. Real costs will be site specific to every application particularly installation costs.

Table 7: Estimated capital and operating costs of automated lamb water iFrenching system

Capital Cost	Current		Current Throughtput w/ 2 shift	
	Cost	Life span	Cost	Life span
Capital Cost of the equipment	$500,000	10	$500,000	10
Total	**$500,000**		**$500,000**	
Service maintenance	**Current**		**Current Throughtput w/ 2**	
	Cost	Units	Cost	Units
Estimated - COSTS				
Electricity	11.00 KW	$0.14 /KWH	11.00 KW	$0.14 /KWH
Maintenance labour (Daily)		$30,698 /Yr		$42,419 /Yr
Operational		**$34,676**		**$47,916**
Annual Sub Total (excluding major overhaul costs)		**$34,676**		**$47,916**
Combined Total: (cap ex + operating)				
Total Annual Estimated Expenses	Years	Cost	Years	Cost
Expected downtime hours per year	7	$23,512 /Yr	7	$23,512 /Yr

Capital costs

Equipment purchase price is based on prices supplied by the manufacturer. Installation costs will be site specific, and will depend largely on the foot print available within the existing plant. Infrastructure upgrades may be required at some plants and allowance has been provided in the model for site specific numbers to be included. The capital cost per head processed will reduce as the total annual number of head processed increases but this will be dependent on mix of customer specifications and the percentage of racks that can be processed through the machine.

Maintenance and service costs

Maintenance and service costs are also supplied by the equipment manufacturer. Maintenance costs are additional running costs that the plants will incur with the installation of the equipment and include components such as parts, labour, power and water. The service contract covers ongoing service and maintenance of the system. The assumption is made that these costs will be a “per head cost” and for this reason the operating costs increase with an increasing production.

Risk of down time

Table 12 shows the conservative calculation used to estimate the cost of down time for an average installation across the wider industry. The automated operation within the plant has

been calculated at one occurrence per week where the stoppages for 15 minutes cause a backlog of product in the room and require an additional 7 slicers on the chain to french racks. The same labour cost used for calculating increases in labour efficiency (Table 7) is used to calculate the cost of down time. The amount of weekly down time is an adjustable figure found on the “Costs” sheet of the model.

6.5.3 System modifications

After this system was installed in the plant there were a number of modifications required. These modifications were required due to differences in product processed between Australia and New Zealand and fine tuning was required to increase the effectiveness of the system.

Frenching Length

The black screws which can be seen in the below image are currently used to modify the frenching length to match the product specifications. Currently on site the frenching length is set to match the product which is frenched a majority of the time. The current process to change the setting required the engineers to modify the frenching length and takes some time. Therefore it is not realistic to swap between specifications frequently across the day. As a result, not all frenched products are done by the machine.

The iFrenching machine could be utilised if the frenching length could be changed automatically, preferably through the push of a button. This would enable the user to change the frenching specification as required and increases the number of racks being processed through the machine.

Figure 10: Mechanisms in the iFrenching system to modify the frenching length, shown by the yellow circles

In feed conveyor

The width between the feed through conveyors shown in Figure 11 needed to be modified after the installation in Australia. The system had the width shown in the below image set to

allow New Zealand lamb racks to pass through. However the issue was that the Australian cap-on rack when frenching a 100mm tail was wider than the New Zealand product.

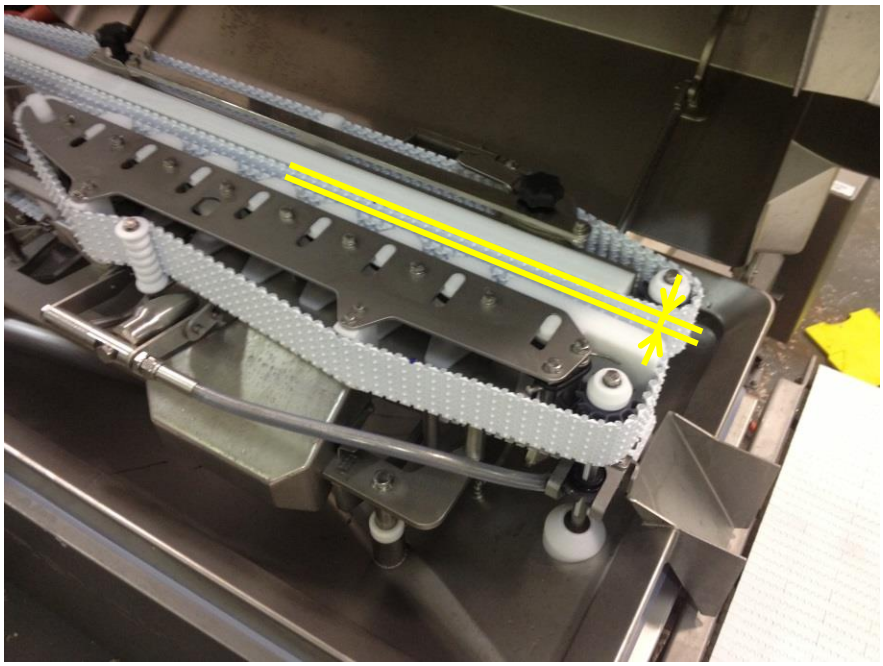

Figure 11: In feed conveyor of the iFrenching system, the width is illustrated by the yellow lines

While the modifications were being made to the in-feed conveyor the feed through conveyor at the bottom of the system as shown in Figure 12 was also modified. The conveyor was replaced with a flat stainless steel plate to reduce the number of moving parts in the system.

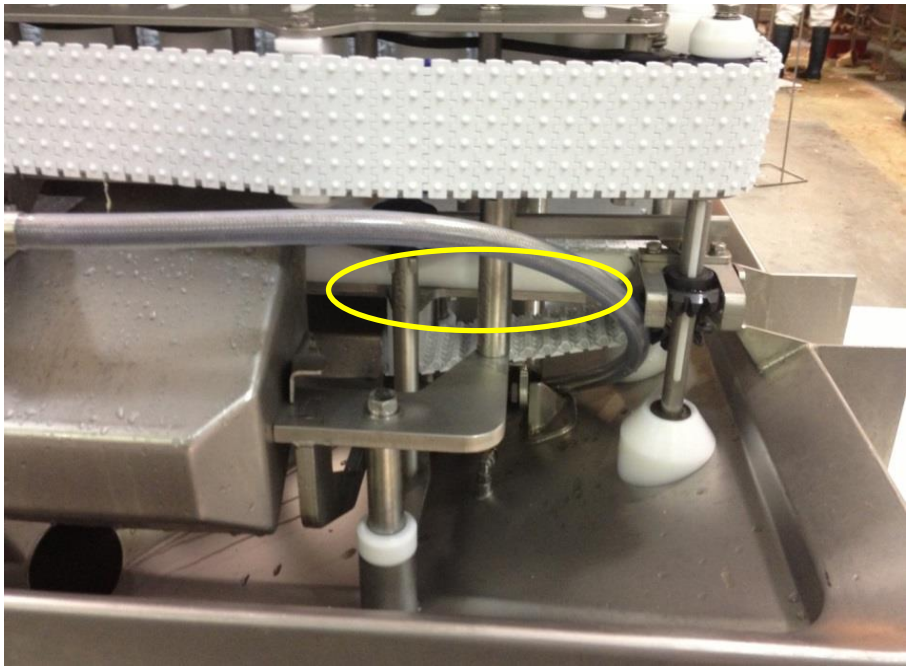

Figure 12: The feed through cover identified by the yellow circle was changed to a stainless steel plate.

Water usage

The water usage per iFrenching system is estimated at 30 litres per minute. This is one of the main contributing factors to the operating costs of the iFrenching system, as there are currently 2 installed in the plant it is estimated that the filtration system needs to process up to 3,600 litres per hour. The following systems have been installed and modified to ensure the water usage is minimised and can exit the system as a consequence of the pressure and amount of water used.

- Installation of the water filtration system
- Pumps to remove the water from the room to the filtration system

Figure 13: Water exiting the lamb iFrenching system.

Post installation of this system, it was identified that due to the pressure of water required to french racks, jets were being loosened. Discussions with the plant supervisors indicated that the jets had to be realigned and a locking mechanism installed. This was in order to ensure the system maintained an accurate frenching line. These jets can also be seen in the below image.

Figure 14: Lamb iFrenching water jets, shown by the yellow circle.

Room and Infrastructure modifications

The affect the installation of the two iFrenching machines (Figure 15) had on the room could be reduced through the following modifications:

- Improvements to the number of cutting specifications the system does automatically, through the modifications mentioned above in the frenching length section.
- Increases capacity at which the frenching systems can operate, thus reducing the number of systems required.

The above points would reduce the infrastructure required and increase the expected savings and return attributed to the installation of the iFrenching system.

Figure 15: Foot print required by the two iFrenching system installed

6.6 Cost Benefit Results

The source of benefits all came from operational efficiencies and labour savings. The summary results in Table 8 demonstrate the performance of the current rate of 7.58 carcases per minute for 1 x 11 hours shift and 2 x 7.6 hour shifts.

The ex-ante net benefit was from $0.23/hd to 0.25/hd. This delivers an estimated return on investment of between 1.70 and 1.88 years depending on the rate at which carcases can be processed.

Table 8: Summary of benefits for the current rate, 4% increase in the rate and the maximum machine speed relative to manual cutting performance

SUMMARY PERFORMANCE MEASURES				
	Current		Current Throughtput w/ 2 shift	
Hd / annum	1,200,672		1,659,110	
Production increase with equipment	8.70%		8.70%	
	From	To	From	To
Capital cost (pmt option, upfront)	$500,000		$500,000	
Gross return Per head	$0.34	$0.32	$0.35	$0.33
Total costs Per head	$0.09		$0.09	
Net Benefit Per head	$0.25	$0.23	$0.26	$0.24
Annual Net Benefit for the plant	$301,581	$273,668	$435,497	$396,926
Annual Net Benefit for the ex cap	$293,393	$265,479	$433,159	$394,588
Pay back (years)	1.70	1.88	1.15	1.27
Net Present Value of investment	$1,969,359	$1,773,308	$3,107,066	$2,836,158

The benefits identified can be broadly summarised as either product value or processing efficiency benefits with the larger portion of benefits being related to processing efficiencies in Figure 16. The frenching system has resulted in some lost product value due to a reduced weight sold as intercostals.

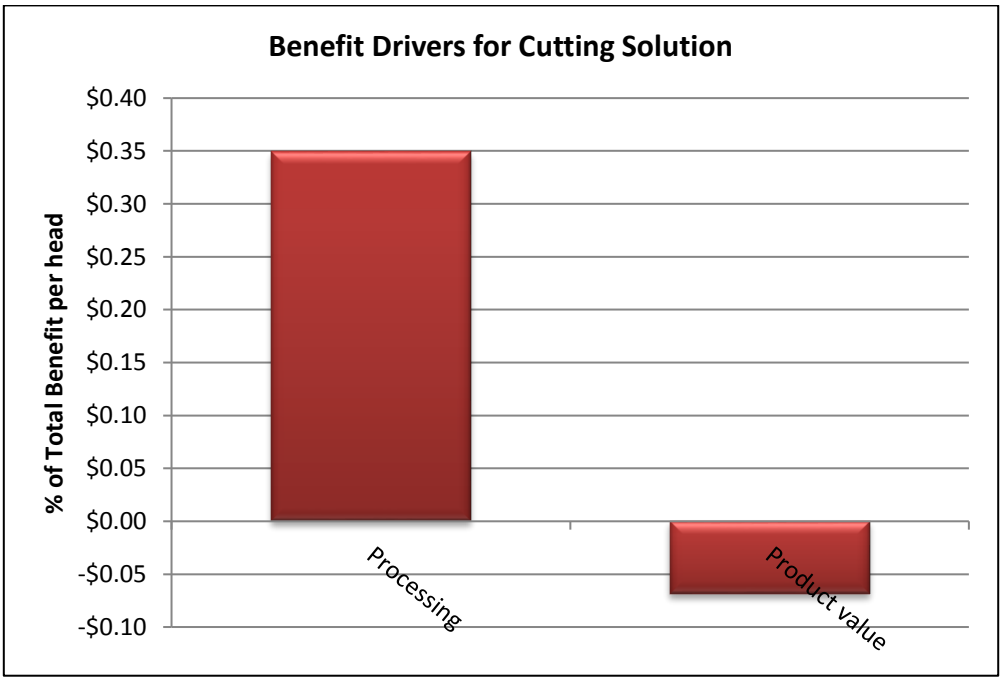

Figure 16: Broad grouping of benefits delivered by the iFrenching system.

The main benefits of the automated system are caused by the labour and OH&S savings. Occupational health and safety costs will be reduced due to the reduction in repetitive strain injuries caused by manually frenching. There may be small yield losses due to the water frenching. The contribution of each individual benefit is summarised in Figure 17 and Table 9.

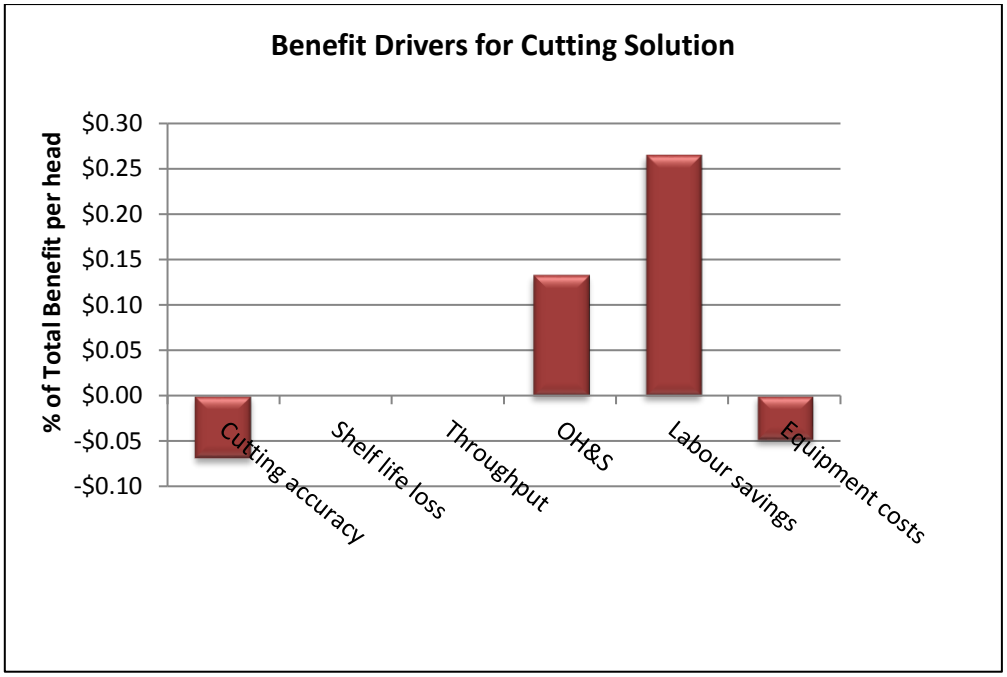

Figure 17: Summary of benefits delivered from the iFrenching system

Table 9: Breakdown of benefits and costs by area

Benefit Drivers for Cutting Solution	Current		Current Throughtput w/ 2 shift	
	$/ hd	$/ annum	$/ hd	$/ annum
Processing	$0.35	$419,707	$0.37	$607,702
Product value	-$0.07	-$82,082	-$0.07	-$113,423
	$0.28	**$337,624**	**$0.30**	**$494,279**
Cutting accuracy	-$0.07	-$82,082	-$0.07	-$113,423
Shelf life loss	$0.00	$0	$0.00	$0
Throughput	$0.00	$0	$0.00	$0
OH&S	$0.13	$160,000	$0.14	$239,418
Labour savings	$0.26	$317,895	$0.27	$439,712
Equipment costs	-$0.05	-$58,188	-$0.04	-$71,428
	$0.28	**$337,624**	**$0.30**	**$494,279**

There have been no increases in labour productivity for the remaining boners and slicers on the line from installation of the iFrenching system. The labour saved does increase the average kilograms for the remaining staff and this increase in productivity caused by the equipment is illustrated in Table 10. The first scenario assumes no room modifications and reflects the increase in average throughput per person by having a consistent flow through the room. The likely increase in the first year of installation will be around 8.70%.

Table 10: Summary of benefits for the installation of the iFrenching System

SUMMARY PERFORMANCE MEASURES	Current	Current Throughtput w/ 2 shift
Hd / annum	1,200,672	1,659,110
Production increase with equipment	8.70%	8.70%

A summary of the range in costs and benefits for each scenario are included in Table 11 below.

Table 11: Ex-ante costs and benefits breakdown for the iFrenching installation

COST - BENEFIT ANALYSIS OF THE SEMI-AUTOMATED CUTTING SOLUTION				
** Cost is reported as the inaccuracy from target specification OR as the difference between Manual vs. Auto costs*	Current		Current Throughtput w/ 2 shift	
Benefit summary	$/hd		$/hd	
	From	To	From	To
$ Accuracy Benefit per head	($0.06)	($0.08)	($0.06)	($0.08)
$ Technique Benefit per head	$0.00	$0.00	$0.00	$0.00
$ Labour Benefit per head	$0.40	$0.40	$0.41	$0.41
$ Automation Costs	($0.05)	($0.05)	($0.04)	($0.04)
$ Overall Benefit per head	**$0.29**	**$0.27**	**$0.31**	**$0.29**

COST ASSOCIATED WITH THE SYSTEM		
	$/hd	$/hd
Capital cost	$0.04	$0.03
Maintenance	$0.00	$0.00
Operation	$0.03	$0.03
Risk of mechanical failure	$0.02	$0.01
Total cost per head	$0.09	$0.07
Total cost per head (EX CAP)	$0.05	$0.04

Table 12 shows the range in value associated with each cost of processing. The cost is calculated as any loss from the maximum benefit possible. Presenting the figures this way in the detailed section of the model demonstrates the total costs involved and highlights areas that future savings could be generated.

Table 12: Summary results of individual costs associated with frenching of lamb racks.

VALUE OF LOSSES DUE TO INACCURACIES AND MANUAL INTERVENTION									
			Manual		Current		Current Throughtput w/ 2 shift		
Loss summary		% of annual production	$/hd From	$/hd To	$/hd From	$/hd To	$/hd From	$/hd To
1.1 Accuracy	Intercostals	41%	$0.00	$0.00	$0.06	$0.08	$0.06	$0.08
1.2 Cutting Technique	Shelf life loss		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2. Throughput cost			$7.18	$7.18	$7.18	$7.18	$7.18	$7.18
3. OH&S losses			$0.17	$0.17	$0.04	$0.04	$0.03	$0.03
4. Labour losses			$0.00	$0.00	-$0.26	-$0.26	-$0.27	-$0.27
Equipment costs	**Maintenance**		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	Operation		$0.00	$0.00	$0.03	$0.03	$0.03	$0.03
	Risk of failure		$0.00	$0.00	$0.02	$0.02	$0.01	$0.01
$ Cost per head			**$7.35**	**$7.35**	**$7.06**	**$7.08**	**$7.04**	**$7.07**

The Figure 18 shows the difference in cost between the systems. Thickness of the box in the graph represents the upper and lower variation in value based on performance variation captured in the data.

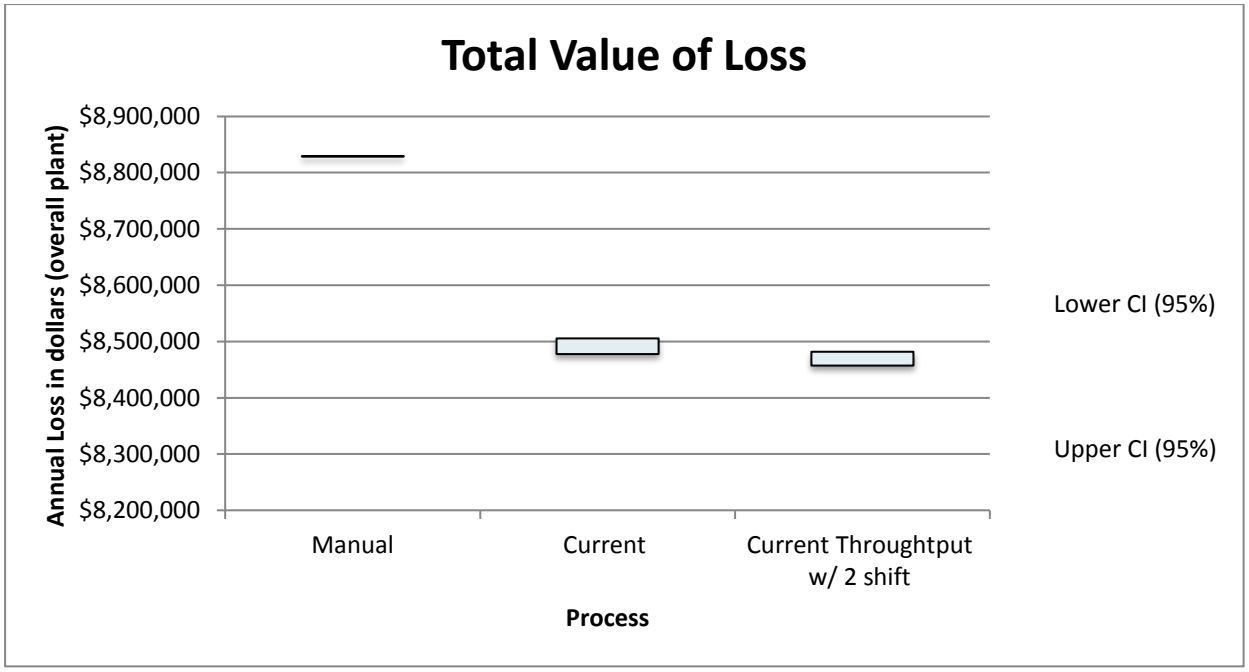

Figure 18: Graphical representation of losses captured in Table 12 showing reduction in loss using the automated systems

7 References

http://www.sawater.com.au/SAWater/YourHome/YourAccountBillPaymentCharges/Pricing+Information.htm

8 Appendices

8.1.1 List of Tables

8.1.2 List of Figures