final report

Project Code: P.PIP.0387

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Date published: August 2013

PUBLISHED BY
Meat and Livestock Australia Limited
Locked Bag 991
NORTH SYDNEY NSW 2059

Ex-Ante CBA for Automated Goat Cutting

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government and contributions from the Australian Meat Processor Corporation to support the research and development detailed in this publication.

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Glossary

Term	Description
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).
Ex-post	The opposite of ex-ante is ex-post (actual)
Statistical hypothesis test	A method of making decisions using data, whether from a controlled experiment or an observational study (not controlled). In statistics, a result is called statistically significant if it is unlikely to have occurred by chance alone, according to a pre-determined threshold probability, the significance level. The phrase "test of significance" was coined by Ronald Fisher: "Critical tests of this kind may be called tests of significance, and when such tests are available we may discover whether a second sample is or is not significantly different from the first."[1]
Caudal	Caudally: toward the posterior end of the body
Cranial	Refers to the direction toward the head of carcass
Dorsal	Belonging to or on or near the back or upper surface of an animal
Ventral	Pertaining to the front or anterior of any structure. The ventral surfaces of the carcass include the brisket /abdomen cavity
HSCW	Hot Standard Carcase Weight
FQ	Forequarter
HQ	Hindquarter
LD	Longissimus Dorsi muscle (or strip loin)
MLA	Meat and Livestock Australia
SLP	Short Loin Pair
TDR	Tender Loin (Psoas major muscle)

Executive Summary

Machinery Automation and Robotics (MAR) in conjunction with MLA are developing a fully automated 6 way cutting and splitting system for smallstock. This report is an ex-ante review of the commercial viability of the system.

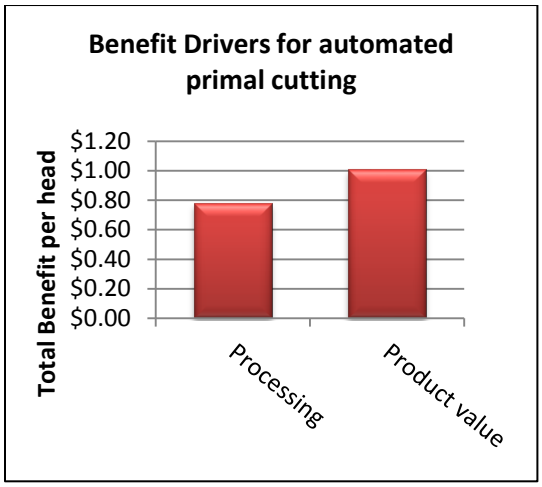
Based on the data analysis and trials conducted at a goat processing plant, the proposed system is expected to deliver return on investment in well under 12 months. Table 1 summarises the investment and likely payback across three scenarios included from left to right:

1. Existing room configuration with 4% increase in throughput due to:
    - Setting a consistent product flow into the room increases volume per person; plus
    - Savings in bandsaw operators total to 14.4% increase in volume per person
    - System operating at 45% of maximum capacity
2. The system operating at 65% of its maximum capacity for one shift per day including overtime
    - This scenario includes reconfiguring room for improved process flows
    - No change in annual volume from current
    - This is the most likely scenario for the plant
3. Scenario 2 but for 2 x 7.6 hours shifts per day
    - This includes increased volume per year resulting in faster payback

Table 1. Summary of benefits for ex-ante costing for a 4% increase in productivity plus bandsaw operator savings (totalling 14.4% labour productivity), the equipment max for one 10 hour shift and the Equipment max for 2 shifts.

SUMMARY PERFORMANCE MEASURES						
	Current w/ ↑ Throughput		EQUIP MAX 1 Shift		EQUIP MAX 2 Shift	
	Hd/ annum	810,950	Hd/ annum	810,950	Hd/ annum	1,238,952
Production increase with equipment	14.40%		40.05%		40.05%	
	From	To	From	To	From	To
Capital cost (pmt option, upfront)	$862,184		$862,184		$862,184	
Gross return Per head	$1.50	$1.50	$1.94	$1.94	$1.94	$1.94
Total costs Per head	$0.16		$0.16		$0.11	
Net Benefit Per head	$1.34	$1.34	$1.78	$1.78	$1.84	$1.84
Annual Net Benefit for the plant	$1,084,867	$1,084,867	$1,444,172	$1,444,172	$2,274,084	$2,274,084
Annual Net Benefit for the ex cap	$1,175,144	$1,175,144	$1,534,449	$1,534,449	$2,366,504	$2,366,504
Pay back (years)	0.73	0.73	0.56	0.56	0.36	0.36
Net Present Value of investment	$7,447,940	$7,447,940	$9,971,548	$9,971,548	$15,815,552	$15,815,552

Substantial benefits could be achieved through the installation of this system including improvements in both production efficiency and increased saleable product value as shown in Figure 1. All product value benefits are from reduction in carcase shrink as a result of warm cutting. The breakdown of benefits is summarised in the figure on the right of Figure 1 and primarily focused on reducing labour, reducing the number of bandsaws and decreasing likelihood of OH&S incidents, as well as improving production efficiencies.



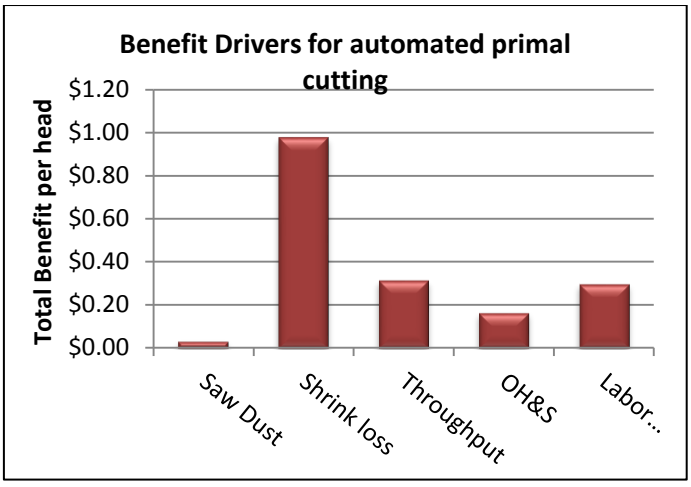


Figure 1. Broad grouping and detailed breakdown of benefits delivered for the Equipment Max 1 shift.

Some plants may choose not to convert from cold cutting to warm cutting and would not reduce chiller shrink. Given chiller shrink is such a large component of the overall benefit, the Table 2 compares the paybacks between warm and cold cutting for the "Equipment max 1 shift" scenario. The remaining processing benefits anticipated with installation of this technology will deliver a payback of close to one year.

Table 2. Return on Investment for warm cutting and cold cutting, factoring for chiller shrink loss

SUMMARY PERFORMANCE MEASURES		
	Cold cutting	Warm cutting
	From	From
Gross return Per head	$0.96	$1.94
Total costs Per head	$0.16	$0.16
Net Benefit Per head	$0.80	$1.78
Annual Net Benefit for the plant	$650,349	$1,084,867
Annual Net Benefit for the ex cap	$716,832	$1,175,144
Pay back (years)	1.20	0.56
Net Present Value of investment	$4,228,950	$9,971,548

1 Introduction

Machinery Automation and Robotics (MAR) are working with MLA to develop a fully automated 6 way cutting and splitting system for smallstock. The project benefits are primarily focused on reducing labour, reducing operational costs and OH&S risks within the plant and improving production efficiencies.

The MAR solution proposes to use two robots with a cutting tool, customised carcase restrainer and sensing system. The plant proposes to provide all services, carcass handling in and out of robot cell, safety guarding and all non-critical component manufacture for fixturing and location of system within a dedicated 6 way cut processing room. Some plant specific infrastructure costs are included in the CBA as they are required to improve the efficiency of the cutting room.

This cost benefit analysis project assesses the commercial viability of a robotic 6 way cut system for Goat processing.

2 Objectives

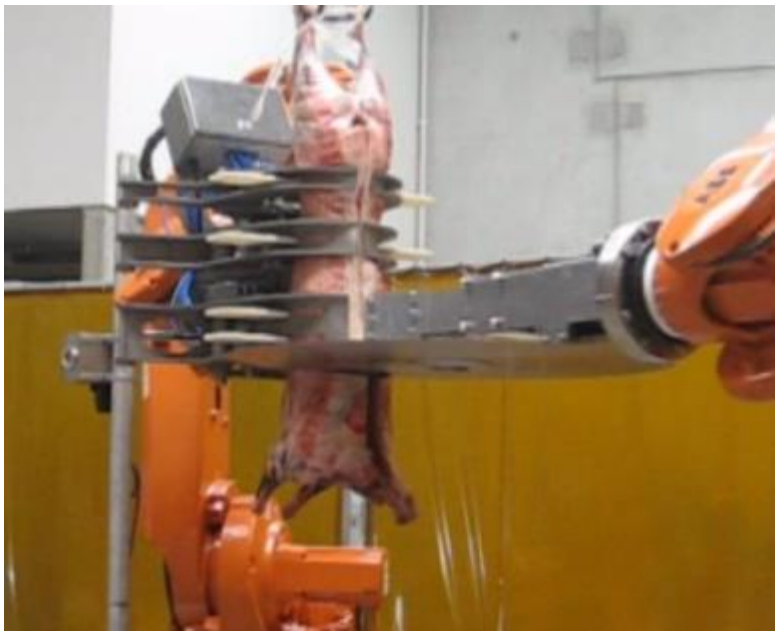
The objectives of this ex-ante study were to:

1. Measure the expected value opportunity of the 6 way goat primal cutting system when compared against manual cutting systems.
2. Summarise the value benefit and main drivers for adoption of the equipment for Australian goat processing.

Both outcomes were achieved effectively.

3 Technology Description

The six way goat cutter is comprised of three main units including visioning, grabbing and cutting of a carcass similar to another automation system shown in the image here. This system will only be required to identify and cut carcases in about the right spot and allow some tolerance in accuracy of cutting specification.



3.1 Visioning

The visioning of the carcase will need to be developed to identify major structural components of a goat, mutton or ram carcase. The accuracy of these points is not important and only needs the robot to dissect different sized carcases. The variation in carcases can be seen in Figure 2. The yellow lines represent the variations that the robotic system will need to account for, through the visioning software.

3.2 Carcase grab

The carcases grab needs to allow for variation in the locations of which the system can dissect carcases into a number of sections. The main considerations required for the development of the grab are to allow for the:

- Dissection of the carcase in the horizontal and vertical directions;
- Variation in carcases sizes;
- Variation in the number of cuts to be conducted on each carcase;

Figure 2, Carcase Variation, Yellow line represents the loin cutting line.

3.3 Materials handling infrastructure

The room will need to be modified to allow for an increased rate of primals moving through the room per hour. This will include changes to the in-feed rails and out-feed conveyors to the packing machines.

3.4 Cuts performed by the automated system

The cuts to be performed by the automated system are shown by the white lines separating the carcase shown in Figure 3; the black lines will still be conducted by the bandsaw. In addition to these cuts the forequarter shank will also be required to be severed by the bandsaw operator to allow for the cuts to fit into a carton.

Figure 3. Cutting lines conducted on the goat carcase, the white lines separating the carcases will be conducted by the automated system and the black lines will be conducted by the bandsaw (Aus-Meat Limited, 2006).

4 Data collection

4.1 Chiller shrink

The current process requires carcases to be chilled for a full day; this result in chiller shrink of between 2.5-4.5% of carcase weight which is standard across the industry. There are no quality protocols preventing abattoirs from processing warm and chilling after packaging. However, it is not possible for bandsaw operators to process warm carcases as they are hard to hold which increases safety risks. The chiller shrink will reduce as a result of automation being able to break down warm carcasses.

The data collected for the chiller shrink calculation was the carcass weights of animals processed through the cutting room and the carcases shrink during the chilling process. The percentage shrink recorded between the automated (2.11%) and manual (0.78%) systems was 1.33%; these values were calculated during a previous trial conducted by the abattoir.

4.2 Cutting yields

There is no yield improvement benefit as a result of cutting accuracy for individual cuts as the goat, mutton and ram markets are a protein commodity purchased on a whole carcase price basis. Customers don't differentiate prices for different cuts.

4.3 Operating and OH & S costs

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

- Staffing levels per shift;
- Cost per hour for staff and AQIS officials;
- OH & S claim costs over the last 10 years;
- Power costs associated with bandsaw and chiller operation;
- Maintenance costs of bandsaws;

These costs have been used to calculate an average operating cost reduction for the areas through the installation of the automated cutting system.

4.4 Shelf life

The automation system will have no effect on shelf life because the majority of products are sold frozen for wet cooking methods.

4.5 Effect of skin-on and skin-off product

Skin on, skin off and brown goat products are processed through the bandsaws. The automated solution can process this same range of products.

4.6 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 3. 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 4.6.1, 4.6.2, 4.6.3 and 4.6.4.

Table 3, Calculation used for determining production volume base line

Processing room operation speeds				
	Manual Process	Current w/ ↑ Throughput	EQUIP MAX 1 Shift	EQUIP MAX 2 Shift
Carcases / min	3.60	3.74	5.50	5.50
Carcases / Statn./hr	216	225	330	330
Room speed	216	225	330	330
Shifts / day	2	2	1	2
Saw Hrs / Shift 1	7.60	7.31	9.95	7.60
Saw Hrs / Shift 2	7.60	7.31	0.00	7.60
Carcases / day	3283	3283	3283	5016
Annual days	247	247	247	247
Annual # of hd	810,950	810,950	810,950	1,238,952

4.6.1 Manual Process

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

- 2 shifts per day with between 18 and 24 people;
- 3.6 carcases processed per minute for a 7.6 hour shift;
- Conducting 10 cuts on bandsaws.

4.6.2 Current process with an increased throughput

The variations between this process and the manual processes are as follows:

- An increase in efficiency of 4% due to consistent cutting rates;
- A reduced number of hours worked per day for the same team;
- The removal of 2 bandsaw operators per shift;
- 5 of the 10 cuts to be conducted by the automated system;

4.6.3 Equipment Max 1 shift

This process maximises the utilization of the automated cutting system and is targeted as the first stage of the installation. The following are the main considerations with this process:

- 1 shift of 10 hour per day on a rotation;
- Processing the current number of carcases per day;
- 5 of the 10 cuts to be conducted by the automated system;
- Infrastructure upgrades in the cutting room to enable faster throughput have been factored into the costing;

4.6.4 Equipment Max 2 shifts

This process has been included in the cost benefit analysis to demonstrate the maximum capacity of the automated system per year. This demonstrates the possible future expansion in capacity of the processing line. These costs do not include the increased sale revenue for this increased throughput.

Note the abattoir already has the capacity to slaughter this number per day. Conversion from cold cutting to warm cutting will give the plant the required carcase chiller capacity.

5 Results

The main value propositions for the installation of the six way goat cutter are attributed to savings in the following areas:

- Reduction in work cover premiums;
- Reduction in operational costs;
- Reduction in chiller loss;
- Increase in labour productivity

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

5.1 Decreased shrinkage through warm cutting

The benefit of the automated solution to saleable product is attributed to a decrease in chiller shrink. The processing chain will be able to be changed from a cold cutting to warm cutting system. If this variation in process was conducted prior to the instillation of the automated system it would increase the OH & S risk posed to the bandsaw operators.

The chiller loss calculation was conducted using the average HSCW of 16kg for animals processed through the cutting room. This weight was than multiplied by the respective losses for either chilled or warm cutting to obtain the estimated yield loss per head. The benefit of warm processing to the plant has been identified to be $0.98 per head as seen in Table 4.

Table 4. The value presented per head between warm and cold cutting.

Shrinkage		
Process	% Shrinkage	$/Hd
Manual	2.11%	$1.55
Auto	0.78%	$0.57
Difference	1.33%	$0.98

5.2 Labour savings

Table 5 shows the number of staff required in each position of the cutting room per day for the manual process. The second column assumes no changes to number of shifts but reflects the saving of 4 bandsaw operators across the two shifts. The third column is the expected scenario for the plant and assumes the plant will move to one shift after automation. The savings of up to 19 labour units per day are associated with increased product flow as a result of process changes enabled by automation and a reduction in supervisors and AQIS inspectors by going to one shift. This plant has an estimated labour savings of $0.45 per head when using the automated primal cutting equipment. The number of staff saved at other plants will depend on the layout of the abattoir's cutting room and chilling and slaughter capacities.

Table 5. Labour savings achieved with automated primal cutting equipment per day

Task	Manual Process	Current w/ ↑ Throughput	EQUIP MAX 1 Shift	EQUIP MAX 2 Shift
Supervisor	2	2	1	2
QA				
Pre Trim	6	6	4	8
Band Saw operator	6	2	1	2
Wrapping Machine	6	6	3	6
Knife hand				
Trimmers				
Packer	14	14	10	20
General Labour				
Maintenance	2	2	1	2
Chiller - Carcase pushing	4	4	2	4
AQIS*	2	2	1	2
Rail Boy	2	2	1	2
Total FTE's required	44	40	24	48
FTE's Saved	0	4	20	-4
Saving per head	$ -	$ 0.32	$ 0.50	$ 0.50

* Calculated at 2 hours per shift at the standard AQIS costing but averaged across the total shift hours.

The reduction in number of staff per shift for the "Equipment max 1 shift" is attributed to the reduction from 2 shifts to 1 shift. Although there will be a reduction by only 10 staff as the shifts will need to be modified to allow for the 10 hours of processing per day.

The equipment max shift 1 and shift 2 have no increase in the staff per shift for the wrapping machine although the line is running faster. This is due to additional infrastructure developed to allow for an increased rate of product flow to remove one of the bottle necks in the room. These savings will vary from plant to plant as a result of the layout of rooms.

5.3 Increased productivity

The main driver behind increases in efficiencies for existing labour is a more consistent throughput of product through the cutting room. The manual processes rely on the bandsaw operator to set the speed at which the carcasses enter the pack off belt. This rate varies depending on the bandsaw operator and carcase size. Variation in carcases weights limits bandsaw operator's ability to lift these carcases. This leads to labourers either operating at less than optimum speeds or a build-up of product where operators are not able to keep up.

One of the main advantages of automated primal cutting equipment is the increases in the consistency of throughput which can improve flow. The improvement in labour productivity is equal to $0.10/head when operating at an estimated 4% increase in rate of processing in the room.

The information detailed in Table 6 demonstrates the increase in efficiency that may be achieved through the room without taking into account the labour savings. This table quantifies the value of increased throughput created by a consistent product flow.

Table 6. Manning of processing room

Increased throughput through the room	Manual Process	Current w/ ↑ Throughput	EQUIP MAX 1 Shift	EQUIP MAX 2 Shift
Average daily hd	3283	3283	3283	5016
Hd/annum	810,950	810,950	810,950	1,238,952
Average kg	16.00	16.00	16.00	16.00
Total Kg boned per day	52,531	52,531	52,531	80,256
Boning room cost / hour	$585	$585	$768	$768
Boning room cost / day	$8,888	$8,546	$7,639	$11,671
Labour cost \ per kg to bone	$0.17	$0.16	$0.15	$0.15
Labour cost \ per hd to bone	$2.71	$2.60	$2.33	$2.33
Labour productivity savings/ head	**$0.00**	**$0.10**	**$0.38**	**$0.38**
Task	**Number labour units - Manual Process (Note - this is gross of labour savings - based on No. of Head above)**			
Supervisor	1	1	1	1
QA				
Pre Trim	3	3	5	5
Band Saw operator	3	3	3	3
Wrapping Machine	3	3	4	4
Knife hand				
Trimmers				
Packer	7	7	12	12
General Labour				
Maintenance	1	1	1	1
Chiller - Carcase pushing	2	2	2	2
AQIS*	1	1	1	1
Rail Boy	1	1	1	1
Total FTE's required	22.0	22.0	30.0	30.0

* Calculated at 2 hours per shift at the standard AQIS costing but averaged across the total shift hours.

5.4 OH & S issues associated with bandsaw operations

The OH & S issues associated with the current processes include the full range of repetitive strain injuries, minor cuts and amputations.

5.4.1 Amputations and minor cuts

Bandsaw operators have had major injuries during the cutting process at the plant. These risks are the highest concern of the abattoir and a major driver for the instillation of the six way goat cutter. Near misses such as shown in Figure 4 are ongoing at the plant and cause for concern. In addition to the physical injuries trauma and confident issues are also associated with bandsaw operators. Near misses have resulted in a high turnover rate in operators of bandsaws, and have been factored into the staff costs per year.

Figure 4, Minor Cuts and grazes that have occurred due to bandsaws.

The 6 way goat cutter will improve the safety of workers cutting goats up in the following ways:

- Decreased number of cuts being conducted by the bandsaw
- Reduced weight that bandsaw operators are lifting when operating the bandsaw.
- Decreased speed at which the cuts are to be conducted

Annual OH&S costs of $174,000 in Table 7 are estimated to reduce by between $114,000 and $133,000 by reducing the number of bandsaws in operation. One bandsaw operator will remain and has been factored in the costs as an ongoing risk. Reductions in OH & S costs are considered conservative with savings for strains and sprains in the following areas not counted in the model:

- Reduction in weight being lifted by the single bandsaw operator;
- Reduced size of pieces being cut;

5.4.2 Strains and sprains

The introduction of the automated system may decrease the number of strains and sprains that occur through the cutting room. This is mainly caused by the reduction in weight that employees are expected to lift of a daily bases. Currently the bandsaw operators lift carcases off the rail as seen in Figure 5. In some instances operators are expected to lift over 50kg.

Figure 5, Lifting carcases and twisting

5.4.3 OH & S savings

Based on the assumptions above, the following frame work in Table 7 shows OH&S Benefits. The estimated OH & S savings that can be achieved through the installation of the automated system is up to $0.17 per head. These costing do not included the associated trauma that can be caused through amputations as these are very difficult to cost.

Table 7: OH&S Benefits of automated goat cutting

OH&S						
	Band Saw cutting	Sprain and Strain from lifting				
Claims in last 10 years	2	10	**Manual Process**	**Current w/ ↑ Throughput**	**EQUIP MAX 1 Shift**	**EQUIP MAX 2 Shift**
Risk / FTE / Year	6.7%	33.3%				
Annual Premium	$149,100	$22,100				
Band Saw Operator Annual Hours			11,263	3,610	2,457	3,754
Limb Losses per year			0.20	0.06	0.04	0.07
Sprains and Strains per year			1.00	0.32	0.22	0.33
Annual Cost			$171,200	$54,872	$37,353	$57,067
Annual Cost / Head			$0.21	$0.07	$0.05	$0.05
Annual saving per head			$0.00	$0.14	$0.17	$0.17

5.5 Operational costs

The main operation costs to be reduced through the implementation of the 6 way goat cutter are associated with the upkeep and power requirements for the current equipment. The main areas of value proposition are associated with the reduction in bandsaws used and the decommissioning of 2 chillers due to warm cutting of carcases.

5.5.1 Manual operation

5.5.1.1 Bandsaws

The value achieved through the decommissioning of two bandsaws will reduce the operational costs of the plant as seen in Table 8. The main costs factored into this costing are as follows:

- Power usage
- Labour for upkeep
- Parts such as blades and bearings

Table 8. Operational costs associated with bandsaw and chiller operations

			810,950	1,238,952
Operational Cost		Cost/year	**Cost / hd**	
Blades (Annual Cost)		$ 15,330	$0.02	$0.01
	Blade unit cost	$ 13.30		
	Blades / day	5	$0.02	$0.01
Cleaning (Annual Cost)		$ 765	$0.00	$0.00
	Cleaning rate ($/hr)	$ 20.66		
	Daily Time	0.15		
	Daily Cost	$ 3.10		
Power		$ 1,016.52	$0.00	$0.00
Bandsaw mechanical costs		$ 4,000.00	$0.00	$0.00
Chiller power costs		$ 23,794.08	$0.03	$0.02
Total annual cost		$ 44,907	$0.04	$0.02
Cost per head		**$ 0.055**	$0.06	$0.04

5.5.1.2 Chiller Costs

The benefits attributed to the introduction of warm cutting have been explained in section 5.2. The additional benefits from the introduction of a warm cutting system will allow for the reduction in chiller space required for chilling carcases.

The warm cutting process to be adopted will reduce chilling time from 20 hours to 2 hours thus dramatically reducing the operational costs per animal. The automated system will allow for 1 to 2 chillers to be removed from production. The benefit to the plant will be reduced power costs estimated between $0.02 and $0.03 per head or $23,794 in savings per year.

The estimated power saving has only incorporated the cost of running the condensers in the chillers. The power saving may be greater than estimated in Table 8 as the cost of running the compressor was not included in these calculations.

5.5.2 Automation costs

5.5.2.1 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 with the existing plant. Cost of the equipment for onsite modifications and installation costs has not been allowed for.

The infrastructure upgraded referred to in Table 9 has been included to increase the capacity of the cutting room to allow for the 5.5 carcases to be processed per minute. The installation of additional equipment to reduce bottle necks in the cutting room will vary from plant to plant.

Table 9 and

Table 10 show 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 9: Estimated capital costs of automated primal cutting equipment

CAPITAL COSTS		
Based on annual product of	810,950	1,238,952
Item	Price	Price
Equipment purchase	$662,184	
Infrastructure upgrade	$200,000	
Total	$862,184	
Annual Deprecation	$86,218	
Cost per head	$0.11	$0.07

5.5.2.2 Maintenance & 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 and labour. The service contract covers ongoing service and maintenance of the automated primal cutting system.

Table 10: Estimated operational costs of automated primal cutting equipment

Annual Cost	Item	Cost / yr	Cost / hd	
	Based on annual # hd		810,950	1,238,952
Operational	Cleaning	2,500	$0.00	$0.00
	Power	5,300	$0.01	$0.00
	Additional MAR support	5,000	$0.01	$0.00
	Ongoing Training	1,500	$0.00	$0.00
	Risk of down time	6,540	$0.01	$0.01
Sub Total (operational)		20,840	$0.03	$0.02
Maintenance	Blades	10,000	$0.01	$0.01
	Maintenance	4,850	$0.01	$0.00
	Materials	2,000	$0.00	$0.00
Sub Total (maintenance)		16,850	$0.02	$0.01
Total		37,690	$0.05	$0.03

5.6 Risk of down time

Table 11 shows the calculation used to estimate the cost of down time. The allowance is made for 1 occurrence per week where the stoppages associated with the equipment would cause the entire room to be at a standstill for 15 minutes. The same labour cost used for calculating increases in labour efficiency 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. Breakage of bandsaw blades in the manual process is quite common and occurs more than 10 minutes per week. Depending on which saw blade breaks some product can be diverted to the other bandsaws while the blade is replaced.

Table 11: Estimated cost of down time

Risk of down time	Manual	Automated	
Total plant down / week (hours)	0.1	0.25	
Number of head/year	810,950	810,950	1,238,952
Hourly labour cost for boning room	$ 545	$ 545	$ 728
Weekly Cost	$ 54	$ 136	$ 182
Annual Cost	$ 2,616	$ 6,540	$ 8,737
Cost per head	$ 0.003	$ 0.008	$ 0.007

6 Cost benefit results

The source of benefits all came from operational efficiencies, decreased shrink loss and labour savings. The summary results in Table 12 demonstrate the performance of the ex-ante machine on a 4% increase in room efficiency, the maximum capacity of the machine for one 10 hour shift per day and the maximum capacity of the system processing carcases for two 7.6 hour shifts per day.

The ex-ante net benefit was from $1.50/hd to $1.94/hd. This delivers an estimated return on investment of between 0.73 and 0.36 years depending on the rate at which carcases can be processed.

Table 12: Summary of benefits for ex-ante, ex-post and maximum machine speed relative to manual cutting performance

SUMMARY PERFORMANCE MEASURES						
	Current w/ ↑ Throughput		EQUIP MAX 1 Shift		EQUIP MAX 2 Shift	
	Hd/ annum	810,950	Hd/ annum	810,950	Hd/ annum	1,238,952
Production increase with equipment	14.40%		40.05%		40.05%	
	From	To	From	To	From	To
Capital cost (pmt option, upfront)	$862,184		$862,184		$862,184	
Gross return Per head	$1.50	$1.50	$1.94	$1.94	$1.94	$1.94
Total costs Per head	$0.16		$0.16		$0.11	
Net Benefit Per head	$1.34	$1.34	$1.78	$1.78	$1.84	$1.84
Annual Net Benefit for the plant	$1,084,867	$1,084,867	$1,444,172	$1,444,172	$2,274,084	$2,274,084
Annual Net Benefit for the ex cap	$1,175,144	$1,175,144	$1,534,449	$1,534,449	$2,366,504	$2,366,504
Pay back (years)	0.73	0.73	0.56	0.56	0.36	0.36
Net Present Value of investment	$7,447,940	$7,447,940	$9,971,548	$9,971,548	$15,815,552	$15,815,552

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 6. Product value benefits are a result of reduced carcase shrink. If the system was to be used on a cold carcases cutting system without the savings in chiller shrink the estimated time for return on investment would be between 2.41, 1.20 and 0.77 years respectively for each scenario in Table 12. Note that increased production speeds in the second and third scenarios are the most likely for goat processing due to limited boning and cutting labour. This gives a payback of well under two years without counting the savings in shrink loss.

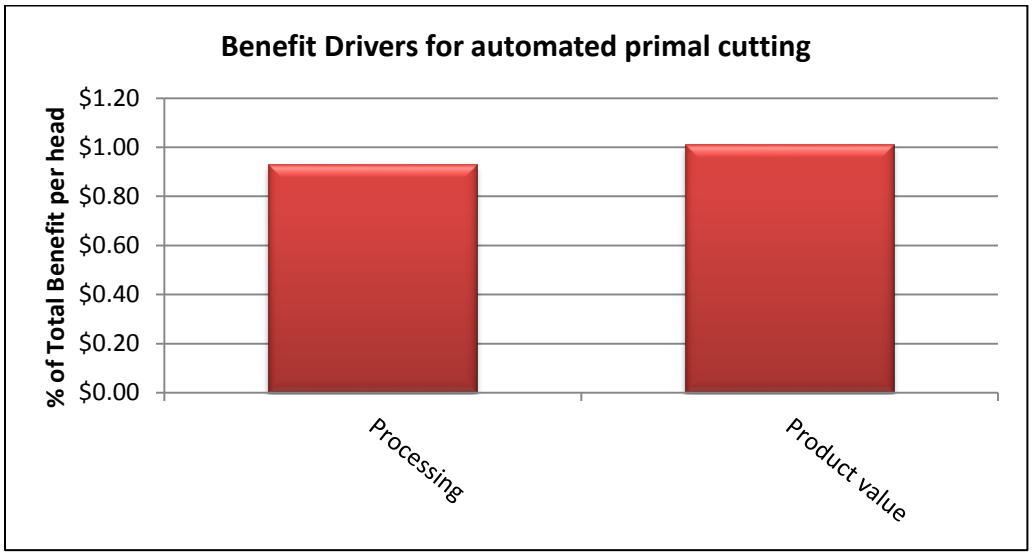


Figure 6: Broad grouping of benefits delivered by automated primal cutting solution for the Equipment Max 1 shift.

The automated equipment will not be required to improve accuracy of cutting lines as compared with manual methods. The main benefits of the automated cutting technology are the ability to cut carcases

warm to reduce shrink, increased labour productivity as a result of more consistent product flows, and a reduction in labour units required. Occupational health and safety costs will reduce by removing bandsaws and reducing primal weights managed through the remaining bandsaws. There may be small yield gains through reduced bandsaw dust but this was not counted in the modelling. The contribution of each individual benefit is summarised in Figure 7 and
Table 13.

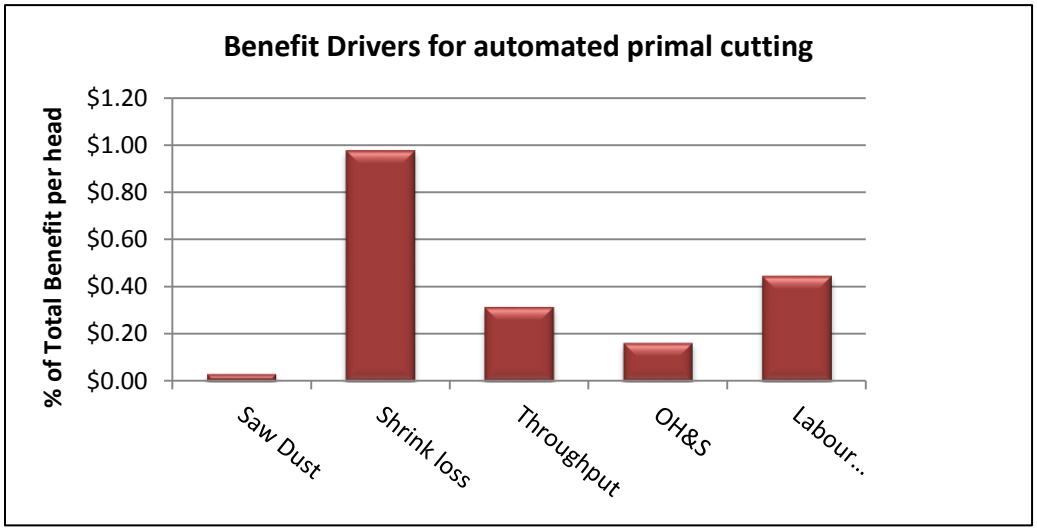


Figure 7: Summary of benefits delivered from automated primal cutting solution for the Equipment Max 1 shift.

Table 13: Breakdown of benefits and costs by area

Benefit Drivers for automated primal cutting			810,950
Sector	% of total	$/ hd	$/ annum
Processing	47.9%	$0.93	$754,351
Product value	52.1%	$1.01	$820,268
	100.00%	**$1.94**	**$1,574,619**
Saw Dust	1.7%	$0.03	$26,445
Shrink loss	50.4%	$0.98	$793,823
Throughput	16.3%	$0.32	$256,747
OH&S	8.5%	$0.17	$133,847
Labour savings	23.1%	$0.45	$363,757
	100.00%	**$1.94**	**$1,574,619**
Capital cost	66.09%	$0.11	$86,218
Maintenance	12.92%	$0.02	$16,850
Operation	15.98%	$0.03	$20,840
Break Down	5.01%	$0.01	$6,540
Total Cost	100.00%	$0.16	$130,447

Increases in labour productivity have been observed with similar types of machines in other processing plants. The expected increase in labour productivity is summarised in

Table 14. The first scenario assumes no room modifications and reflects the increase in throughput by having a consistent flow through the room. The likely increase in the first year of installation will be around 26% in the second scenario which includes some room modifications and labour savings by reducing from two shifts to one shift.

Table 14: Summary of benefits for the installation of MAR automated primal cutting system.

SUMMARY PERFORMANCE MEASURES						
	Current w/ ? Throughput		EQUIP MAX 1 Shift		EQUIP MAX 2 Shift	
	Hd/ annum	810,950	Hd/ annum	810,950	Hd/ annum	1,238,952
Production increase with equipment	14.40%		40.05%		40.05%	

A summary of the range in costs and benefits for each scenario are included in Table 15 below.

Table 15: Ex-ante costs and benefits breakdown for the installation at 5.5hd/minute

COST - BENEFIT ANALYSIS OF ROBOTIC PRIMAL CUTTING EQUIPMENT						
** Cost is reported as the inaccuracy from target specification OR as the difference between Manual vs. Auto costs*						
Benefit summary	$/hd		$/hd		$/hd	
	From	To	From	To	From	To
$ Technique Benefit per head	$1.01	$1.01	$1.01	$1.01	$1.01	$1.01
$ Labour Benefit per head	$0.49	$0.49	$0.93	$0.93	$0.93	$0.93
$ Automation Costs	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01
$ Overall Benefit per head	**$1.50**	**$1.50**	**$1.95**	**$1.95**	**$1.95**	**$1.95**

COST ASSOCIATED WITH THE EQUIPMENT			
	$/hd	$/hd	$/hd
Capital cost	$0.11	$0.11	$0.07
Maintenance	$0.02	$0.02	$0.01
Operation	$0.03	$0.03	$0.02
Risk of mechanical failure	$0.01	$0.01	$0.01
Total cost per head	$0.16	$0.16	$0.11
Total cost per head (EX CAP)	$0.05	$0.05	$0.04

Table 16 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 16: Summary results of individual costs associated with automated primal cutting of lamb carcasses

VALUE OF LOSSES DUE TO INACCURACIES AND MANUAL INTERVENTION									
		Manual Process		Current w/ ↑ Throughput		EQUIP MAX 1 Shift		EQUIP MAX 2 Shift	
Loss summary		$/hd From	$/hd To	$/hd From	$/hd To	$/hd From	$/hd To	$/hd From	$/hd To
1.2 Cutting Technique	Saw dust loss	$0.03	$0.03	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	Shrink loss	$1.55	$1.55	$0.57	$0.57	$0.57	$0.57	$0.57	$0.57
2. Throughput cost		$2.52	$2.52	$2.43	$2.43	$2.21	$2.21	$2.21	$2.21
3. OH&S losses		$0.21	$0.21	$0.07	$0.07	$0.05	$0.05	$0.05	$0.05
4. Labour losses		$0.00	$0.00	-$0.25	-$0.25	-$0.45	-$0.45	-$0.45	-$0.45
Equipment costs	**Maintenance**	$0.00	$0.00	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02
	Operation	$0.06	$0.06	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03
	Risk of failure	$0.00	$0.00	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01
$ Losses per head		**$4.38**	**$4.38**	**$2.88**	**$2.88**	**$2.43**	**$2.43**	**$2.43**	**$2.43**
$ Annual Losses overall plant		**$3,551,302**	**$3,551,302**	**$2,331,929**	**$2,331,929**	**$1,972,623**	**$1,972,623**	**$1,971,929**	**$1,971,929**

The Figure 8 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.

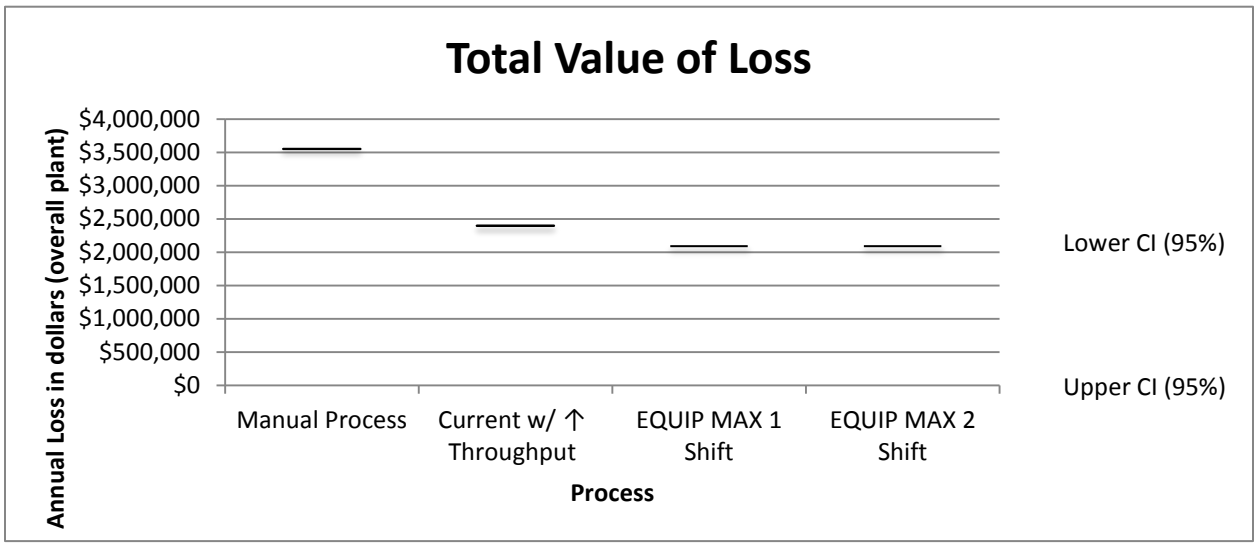


Figure 8: Graphical representation of losses captured in Table 16 showing reduction in loss using the automated systems

7 References

Aus-Meat (2006), Cut Specifications, (Goat meat Primal cuts) Sourced online at Aus-Meat viewed 26th August, 2013, From: http://www.ausmeat.com.au/custom-content/cdrom/Handbook-7th-edition/English/3BC2418D-F68C-11DA-AA4B-000A95D14B6E.html

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