Final report

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Radford 2D Traceability in Smallstock Processing

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Executive Summary

R. Radford & Sons Pty Ltd introduced a two-dimensional (2D) bar code tracking system at its processing plant in Warragul. A 2D bar code tracking system is an enabling technology that will allow the tracking of small stock carcasses through slaughter and enable individual carcase data collection which can be used by the National Livestock Identification System, producers and other supply chain participants. The manual system previously used a mob based system that weighed lamb carcases in groups of ten, averaged the data for each lamb and could not provide individual animal identification. This document identifies the value opportunity identified at the Warragul plant through the installation of the 2D bar code based system (**stage one**) versus no tracking baseline. A proposed **stage two** was scoped which includes additional infrastructure that could provide benefits beyond that of stage one. The 2D bar code tracking system is a traceability solution suited to smaller processing plants.

The methodology for the cost benefit analysis was to:

1. Conduct a cost benefit analysis to quantify potential benefits and savings for all scenarios (baseline, stage one and stage two).
2. Identify and quantify a range of additional benefits at a broader level along the supply chain.
3. Review the relative costs/benefits between a mob based and individual animal based identification system, with a specific focus on assessing whether individual animal based identification would increase industry benefits.

Results

The stage one (and stage two) system does not deliver an acceptable return on investment in pure financial terms. However, it updates from manual processes to use of smart technology and provides capabilities that are required to underpin other activities such as value based marketing. In this respect the system would be considered an enabling technology. If the 2D barcode system was linked to a Dual-energy x-ray absorptiometry enabling collection of lean meat yield, the return on investment could be improved. However, the cost benefit would need to be considered since such technologies have a large capital cost.

The net benefit of the stage one traceability system is estimated at $0.11 per head if current throughput is maintained. This would deliver an estimated return on investment of **6.37 years** and a net present value of **-$126,372**. The net benefit of the stage two traceability system is estimated at $0.13 per head if current throughput is maintained. This would deliver an estimated return on investment of **6.03 years** and a net present value of **-$113,130**. The source of all benefits for both the stage one and stage two 2D traceability system are short-term and long-term, coming from reduced carcase defects and reduced downtime from stoppages. The proposed stage two traceability system would increase benefits from potential sales optimisation and hence reduce the payback period.

In addition to direct company benefits, the installation provides a more robust system for monitoring animal movements for disease traceability. Regional or national traceability provides supports risk management strategies with biosecurity and market access benefits. These wider industry benefits were not costed as a part of this project.

Contents

Glossary

Term	Description
2D	Two-dimensional
CBA	Cost Benefit Analysis
CCW	Cold Carcase Weight
DEXA	Dual-energy x-ray absorptiometry
FTE	Full time equivalent
HCW	Hot Carcase Weight
LMY	Lean Meat Yield
MLA	Meat and Livestock Australia
OCM	Objective carcase measurement
RFID	Radio-frequency identification
Radfords	R. Radford & Sons Pty Ltd

1 Introduction

R. Radford & Sons Pty Ltd (Radfords) introduced a two-dimensional (2D) bar code tracking system at its processing plant in Warragul. A 2D bar code tracking system is an enabling technology that will allow the tracking of small stock carcasses through slaughter and enable individual carcase data collection which can be used by the National Livestock Identification System, producers and other supply chain participants. This document identifies the value opportunity identified at the Warragul plant through the installation of the 2D bar code based system (**stage one**) versus no tracking baseline and a proposed **stage two** being additional infrastructure to the stage one installation potentially enabling additional benefits.

This traceability project was co-funded by Meat and Livestock Australia (MLA) and the Department of Environment and Primary Industries and developed and trialled software that uses low cost 2D bar coding to track small stock carcasses through slaughter. This will allow data to be collected for potential use for the National Livestock Identification System, producers and other supply chain participants. It is envisioned that the 2D bar code tracking system is a traceability solution for smaller processing plants.

2 Objectives

The objective is to perform a cost benefit analysis of the 2D bar code traceability system installed as part of stage one versus a baseline with no tracking system and proposed stage two works to the reasonable satisfaction of MLA. Specifically the project intends to:

1. Conduct a cost benefit analysis to quantify potential benefits and savings, including:
    - Potential labour savings.
    - In-plant efficiency savings.
    - OH&S savings.
    - Capital and installation costs.
    - Economic Impact at a plant level across the supply chain.
    - Reliability.
    - Maintenance Costs.

2. Identify and quantify a range of additional benefits at a broader level along the supply chain including:
    - Traceability.
    - Increased sortation.
    - Management savings.
    - Food safety.
    - Market access.
    - Animal welfare.

3. Review the relative benefits between a mob based and individual animal based identification system in relation to the cost/benefits, with a specific focus on assessing whether individual animal based identification would increase industry benefits over a mob based information approach.

The above benefits will be based on a set of actual and potential (objective/subjective) carcase measurements and animal health data that could be transmitted along the supply chain to producers. This will form a foundation for the more detailed objective carcases measurement (OCM) strategy analysis to be carried out as a separate project.

3 Technology Description

2D barcode label systems are a label system that store large amounts of information as machine-readable, black and white patterns, rather than lines and spaces used in single dimensional barcodes. They were invented to improve data capacity and operate as portable databases when scanned and decoded by camera-equipped mobile devices. Information from radio-frequency identification systems from ear tags are transferred to the 2D barcode labels, thus allowing automatic recognition and the unique identification of every object and is a solution for individual animal traceability where desired and satisfies the 'Paddock to Plate' objectives of the National Livestock Identification System. Radio-frequency identification systems are a comparable technology but more expansive. It was envisioned that the 2D barcode system would be a traceability solution for smaller processing plants. The following details the progressive points on the slaughter floor where the carcases would be monitored using the proposed 2D barcode system:

- Animal origin
- Carcase defects
- Individual animal carcase weights
- Animal sale locations (carcase sales and load out)
- Animal purchase and sales prices
- Reliable hot carcase weight scales which are industry appropriate for use.

Although the objective of this project is to undertake a cost benefit analysis of the 2D barcode system, a primary focus of Radfords was to increase the accuracy within their processing plant through the transition from the paper based system (no tracking baseline) to smart technology (installed as part of stage one). The stage one system has been a major technology upgrade for the plant that will reduce the time spent on data entry and error mitigation by senior staff.

With the implementation of stage one, the processes occurring at the plant now currently are:

1. Carcases are tracked from the knocking box to the weighing station through electronic counters on the rail.
2. If a carcase is retained for further trimming, carcase tags are attached identifying the carcases number and defect, this information is then entered at the weighing station.
3. The carcase tags are then scanned during the loading of trucks and are added to the invoices and delivery dockets.
4. Through identifying all carcases and destinations of carcases loaded, truck drivers are assured that trucks are not overloaded when exiting the facility.

4 Methodology

4.1 Areas of Benefit

The 2D bar code traceability system of lamb carcases on the slaughter floor is an enabling technology that allows processors to collect detailed information on each individual carcase and provides an opportunity for the processors to feedback the detailed information to producers. The manual system previously used at the plant worked on a mob based system that weighed lamb carcases in groups of ten and averaged the data for each lamb. Additionally, the data was documented manually by writing dockets and later entered to the system causing errors and consuming time. The methodology for the cost benefit analysis was to assess multiple scenarios including the two stages of development detailed below:

1. Baseline of no tracking system (mob based approach described above)
2. Stage one – Implementation of the 2D bar code traceability system of carcases on the slaughter floor.
3. Stage two - the traceability system as an enabling technology for future investments.

Stage one and stage two are both enabling factors for future technology since it included updates from the manual processes to use of smart technology.

The potential cost/benefit of this project are short-term and long-term benefits and are discussed in more detail below.

Short-term cost/benefit:

- Potential labour savings.
- Throughput efficiencies.
- Reduction in workplace health and safety (WH&S) costs.
- Capital and installation costs.
- Reliability of capital.
- Maintenance costs.
- Increased accuracy of data collected.

Longer-term cost/benefit:

- Reduction in retained carcases.
- Carcase sale optimisation.
- Reduced chiller shrink.

The methodology for quantifying the value of the benefits are detailed below.

4.2 Retained Carcases

Carcases which are identified as having contamination and defects are removed from the main rail for trimming as required. These carcases are then trimmed to remove issues prior to having the hot carcase weight recorded, resulting in a lost weight for the producer and loss opportunity for the processor. Through identifying the defects of any carcases or part carcases condemned, producers can then work to overcome these problems. The benefits of identifying individual carcases which are retained are as follows:

Processor

- Decreases lost weight of carcases resulting from defects.
- Increases saleable meat through reducing losses.
- Reduced losses when live weight purchased animals are condemned.

As this plant purchases a large portion of lamb carcases through sale yards they absorb most of the costs associated with trimming carcases.

4.3 Operating and WH&S Costs

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

- Staffing levels per shift.
- Cost per hour for staff.
- WH&S claim costs over the last 10 years.
- Power costs.
- Maintenance costs.
- Consumable costs associated with printing tags.

These costs have been used to identify the current average operating costs and calculate the subsequent average operating costs after the installation of the stage one and stage two 2D traceability system.

4.4 Fixed Model Drivers

To establish the dollar value per head of each of the costs and benefits, the following production numbers were used (refer *Table 1*). This 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. Both of these scenarios are detailed further below.

Table 1: Calculation used for determining production volume base line

Operation speeds			
	Manual	2D Traceability - Stage 1	2D Traceability - Stage 2
Carcases / min	1.25	1.25	1.25
Carcases / Statn./hr	75	75	75
Carcases / day	570	570	570
Annual days	192	192	192
Annual # of hd	**109,440**	**109,440**	**109,440**

4.4.1 Manual Process

The manual tracking process limited the ability to track individual carcases. This system only allowed for group tracking (mob) of carcases without the ability to record and provide individual carcase feedback to producers. Additionally, it was not a suitable method for individual animal traceability for the National Livestock Identification System.

4.4.2 2D Traceability System – Stage One

The 2D traceability system has been a major upgrade to the plant, however as demonstrated in *Table 1* the throughput volumes have not increased. However, the following changes have been made to the staffing requirements:

- 1 full time equivalent (FTE) staff member added to the slaughter floor.
- Reduction in the down time of the slaughter floor.
- Reduced reliance on staff for data entry.

The cost and benefits of these modifications are discussed further in the results section below.

4.4.3 2D Traceability System – Stage Two

The enabling capability volume on the far right of *Table 1* uses the changes to labour requirements as described in section 4.4.2. However in has included additional benefits through utilising the data to increase the value of lambs purchased.

5 Results and Discussion

The stage one installation of the 2D barcode traceability system results in a medium-term return on investment when compared to the baseline of no tracking system (existing manual mob based system). The main value proposition for the installation of a lamb traceability system is to increase the feedback to producers and subsequently increase quality of carcases and offal. An additional value proposition to the processor is the transition to smart technology that will enable additional benefits in the future. A key intangible benefit of the 2D barcode traceability system (stage one and stage two) is its future enabling capability.

A summary overview of the costs and benefits of the stage one installation (compared to the no tracking baseline) are:

- Reduction in workload for QA staff, load out supervisor and marketing team.
- Decreased slaughter floor productivity since increase to slaughter floor by one FTE, which was required to weigh and attach the carcases tags. Throughput is maintained.
- Reduction in time the slaughter floor is at a standstill due to the carcase washer having to move 10 carcases on and off the scales.
- Intangible benefit as an enabling technology.

The primary difference in benefit between the stage one installation and proposed stage two installation is an increased return on investment because of the increased/additional benefit of better utilisation of data collected to maximise the sales value of all lambs processed.

All costs and benefits are discussed further below.

5.1 Labour

5.1.1 Increase in Staff Numbers

There are no labour savings for both stage one and the proposed stage two however there are time savings for senior personnel. An additional FTE staff member was required on the slaughter floor to weigh and attach the carcase tags. The benefits of this additional person reduces the quantity of time the slaughter floor is at a standstill because of the previous process used as part of the manual system. Additionally, there are time savings (labour savings) for senior personnel specifically QA staff, load out supervisor and the marketing team because of the transition to the smart technology system.

Total labour costs/benefits are:

- Increased staff numbers on the slaughter floor.
- Increased cost of labour per kilogram processed.
- Decreased workload for QA staff, load out supervisor and the marketing team.

Table 2 shows the modifications to labour at the plant. The number of staff required in each position of the slaughter floor per day for the no tracking baseline (manual process), stage one and stage two 2D traceability system.

The benefits of the labour changes will result in the additional benefits detailed below:

1. Decrease staff overtime paid (constant productivity flow, reduced standstill).
2. Increase time for senior managers to implement other changes.

The tangible value of these costs/benefits are included in Table 2.

Table 2: Labour requirements for boning and slaughter floors.

Labour Savings per day			
	Number labour units required per day		
Task	Manual	2D Traceability - Stage 1	2D Traceability - Stage 2
Slaughter floor	25	26	26
QA Supervisor	1	1	1
Load out Supervisor	1.2	1.0	1.0
Marketing	2	2	2
Chillers	5	5	5
	0	0	0
Total FTE's required	34.2	35.0	35.0
Total FTE's saved	-	- 1	- 1
Saving per head	$0.00	-$0.40	-$0.40

The increased labour costs are estimated to be $0.40 per head based on increasing 1 FTE personnel and decreasing overtime for the load out supervisor, refer to *Table 3* for detailed labour calculations.

5.1.1 Decreased Productivity

Productivity has slightly decreased with the increase of personnel on the slaughter floor. There is no throughput efficiency increase and with the additional staff member this results in a decreased productivity. This is the same for both the installed stage one and proposed stage two traceability system.

5.2 WH&S

The main WH&S costs/benefits are impacts to WH&S premiums. Because of the overall increase to personnel numbers (one FTE staff member on the slaughter floor and reduced overtime for senior personnel) there is a slight increase in WH&S premiums. Neither the installed stage one or proposed stage two traceability system is expected to impact the current WH&S risk of incident at the site from the manual baseline.

5.3 Operational Costs

Table 3 shows the total cost of the equipment Including both capital and operational costs including the benefit from reduced downtime hours or standstill hours which results from the new technology and increased personnel on the slaughter floor. Real costs will be site specific to every application particularly installation costs.

Table 3: Estimated capital and operating costs of automated x-ray primal cutting equipment

Capital Cost	Manual		2D Traceability - Stage 1		2D Traceability - Stage 2	
	Cost	Life span	Cost	Life span	Cost	Life span
Capital Cost of the equipment			$145,450	10	$145,450	10
Cabling			$20,000	10	$20,000	10
Server upgrade			$45,000	10	$45,000	10
Other Capital install				10		10
Total			**$210,450**		**$210,450**	
Service maintenance	Manual		2D Traceability - Stage 1		2D Traceability - Stage 2	
	Units	Cost	Units	Cost	Units	Cost
Estimated - COSTS						
Electricity		$0.22 /KWH		$0.22 /KWH	0.00 KW	$0.22 /KWH
Maintenance labour (Daily)		0.00 /Yr		29548.80 /Yr		29548.80 /Yr
Maintenance labour (Preventative)		0.00 /Yr		0.00 /Yr		0.00 /Yr
Maintenance labour (Breakdown)		0.00 /Yr		0.00 /Yr		0.00 /Yr
Maintenance labour (Training)		0.00 /Yr		0.00 /Yr		0.00 /Yr
Operational		**$0**		**$29,549**		**$29,549**
Maintenance		**$0**		**$0**		**$0**
Annual Sub Total (excluding major overhaul costs)		**$0**		**$29,549**		**$29,549**
Combined Total: (cap ex + operating)						
Total Annual Estimated Expenses	Hours	Cost	Hours	Cost	Hours	Cost
Expected downtime hours per year	48.00	$68,621/Yr		0.00 /Yr	0	0.00 /Yr

5.3.1 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 footprint available within the existing plant. Infrastructure upgrades may be required at some plants and an 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.

5.3.2 Maintenance and Service Costs

Maintenance and service costs are also supplied by the equipment manufacturer. Maintenance costs are additional running costs that the plant 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 system. The assumption is made that these costs will be a “per head cost” and for this reason no reduction in these costs is seen with increasing production.

5.3.3 Risk of Down Time

The labour costs used for calculating increases in labour efficiency (*Table 3*) are also 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.

To estimate the cost of down time for an average installation, an allowance is made for one hour of stoppages per week. For the no tracking baseline (pre installation of the 2D tracking system) the staff member that cleaned the carcases also moved the carcases over the sales. This process caused the operator to stop the room in order to catch up on a daily basis, totalling an approximate value of 48 hours per year. The stage one and proposed stage two 2D traceability system is estimated to have zero down time (based on process improvement and actual site inspections after stage one installation). This is because the technology is reliable and with the additional staff member added to the slaughter floor the staff member that cleans the carcases focuses solely on that task and therefore maintains

the pace required and doesn't need to stop the room, resulting in a processing saving equivalent to the cost of stoppages for the no tracking baseline.

5.4 Reduced Carcase Contaminations

The installation of the stage one 2D traceability system has enabled the processing plant to record all contaminations on a per individual carcase basis and subsequently reduce the number of carcases retained by providing feedback to the producer. Based on a market value approach, there are benefits that will be realised by both the processor and producer. The benefits to the plant will need to be realised through assessing the data collected on a season basis over a number of years.

Process to be used by processor:

- Identify locations and suppliers of heavily contaminated carcases.
- Restrict purchases accordingly to reduce purchasing heavily contaminated stock, this may mean altering sourcing from specific locations at different times of the year.

Because Radfords purchases a large portion of lamb carcases through sale yards they absorb most of the costs associated with trimming carcases so there is a reduced benefit to producers by providing feedback on herd health data. However, producers would still benefit and be motivated since the feedback may provide data about the genetic superiority of lean meat yield and/or herd health such as liver fluke which decreases the rate of growth achieved by the producer and therefore decreases the total cost efficiency.

Table 4: Areas of short and longer term benefits for processors

Capability	Profit Improvement Results	Benefit Achievable		Percentage of Benefit Achievable	
		2D Traceability - Stage 1	2D Traceability - Stage 2	2D Traceability - Stage 1	2D Traceability - Stage 2
Reduced Carcase Contamination					
Ovis in meat tissue - reduce trim loss	Reduced trim yield loss - Reduction in carcase downgrades and more accurate assessment of nodule site	$ 92	$ 246	30%	80%
Pre-boning inspection	Reduced trim yield loss - Reduction in chiller trimming - Wool Dust, ingesta and other contamination	$ 1,616	$ 2,586	50%	80%
Identify abscess from seeds	Reduce carcase trimming and increase yield	$ 95	$ 230	33%	80%
Ovis in meat tissue - reduce downgrades	Reduction in carcase downgrades due to more accurate assessment	$ 82	$ 219	30%	80%
Enabling Capabilities					
Sales - Optimise carcase value	Optimise carcase value	$ -	$ 36,115	0%	100%
Sorting for Chiller Shrink	Reduced shrink	$ -	$ 92.45	0%	80%
TOTAL SAVINGS		$ 1,885	$ 39,488		

5.5 Enabling Capability

The enabling capability of the proposed stage two 2D traceability system is carcase sale optimisation. The net benefit between stage one installed and the proposed stage two system is $0.02 per head is the largest area of benefit as an enabling factor for the processor, through the following weight:

1. Sort carcases post chilling into specific carcase weights, selecting carcases of the highest value to match the customer's specifications.
2. Increase ability of marketing team to sell tighter group carcase specifications as a result of having individual carcase weights.

The enabling capability of the stage two 2D traceability system improves the return on investment from 6.37 years to 6.03 years for a minimal increased cost, refer *table 6* below.

If the 2D traceability system were extended to boning and linked to a LMY measurement technology such as a Dual-energy x-ray absorptiometry (DEXA) as well as value based marketing, it would enable further benefits for the producer and processor. However the cost verse benefit would need to be considered, as the cost to install and integrate the technologies (2D barcode system and a DEXA) could be considerable.

5.6 Cost Benefit Analysis

5.6.1 Summary of Performance Measures

The source of benefits all come from increased LMY for the stage one 2D traceability system whilst the proposed stage two traceability system would have increased benefits because of the sales optimisation capacity. The summary results in *Table 5* demonstrate the performance that can be realised from the stage one and proposed stage two traceability system. The net benefit of the stage one traceability system is estimated at $0.11 per head if current throughput is maintained. This would deliver an estimated return on investment of 6.37 years and a net present value of **-$126,372**. The net benefit of the stage two traceability system is estimated at $0.13 per head if current throughput is maintained. This would deliver an estimated return on investment of 6.03 years and a net present value of **-$113,130**.

Table 5: Summary of benefits.

SUMMARY PERFORMANCE MEASURES		
	2D Traceability - Stage 1	2D Traceability - Stage 2
Hd / annum	109,440	109,440
Production increase with equipment	-2.29%	-2.29%
	Avg.	Avg.
Capital cost (pmt option, upfront)	$210,450	$210,450
Net Benefit Per head	$0.11	$0.13
Annual Net Benefit for the plant	$ 11,971	$ 13,856
Annual Net Benefit for the ex cap	$ 33,016	$ 34,901
Pay back (years)	6.37	6.03
Net Present Value of investment	($126,372)	($113,130)

5.6.2 Benefit Drivers

The benefits identified for both stage one and proposed stage two can be broadly summarised as product value benefits and some processing benefits. The processing cost includes the benefit from reduced standstill minus the cost from additional labour. The benefits are mostly product value benefits, refer *figure 1*.

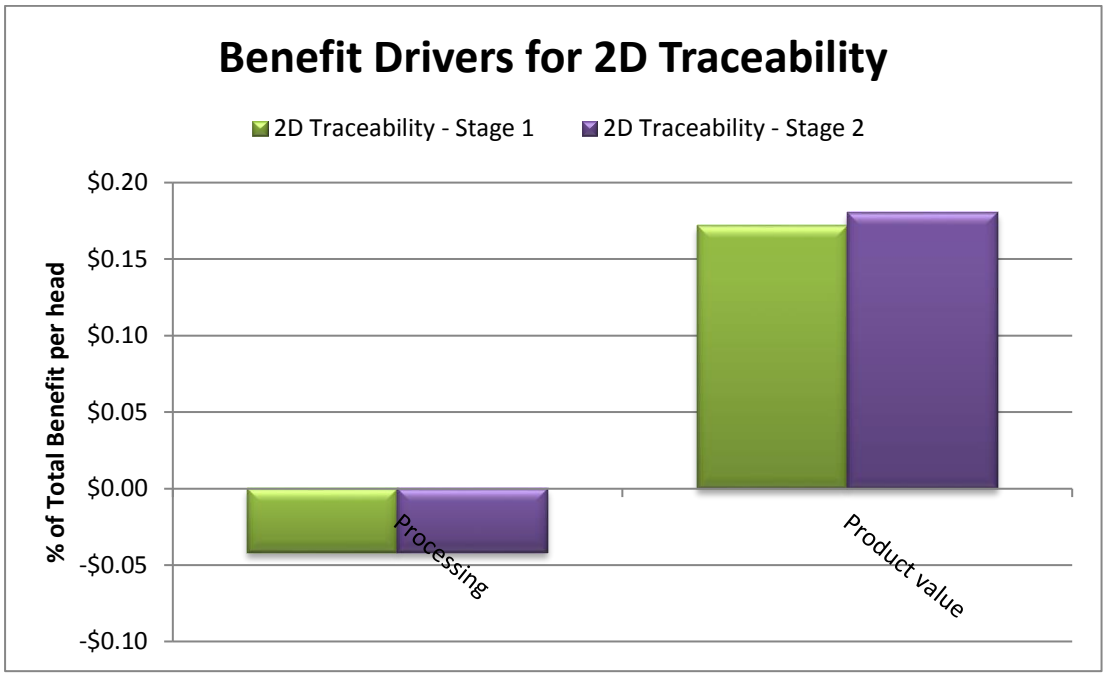

Figure 1: Broad grouping of benefits delivered traceability system for stage 1 and 2.

5.6.3 Breakdown Benefit Drivers

The main benefits of the stage one and stage two traceability system are increased value from product value and equipment benefits from reduced plant standstills. The contribution of each individual benefit is summarised in *Figure 2* and *Table 6*.

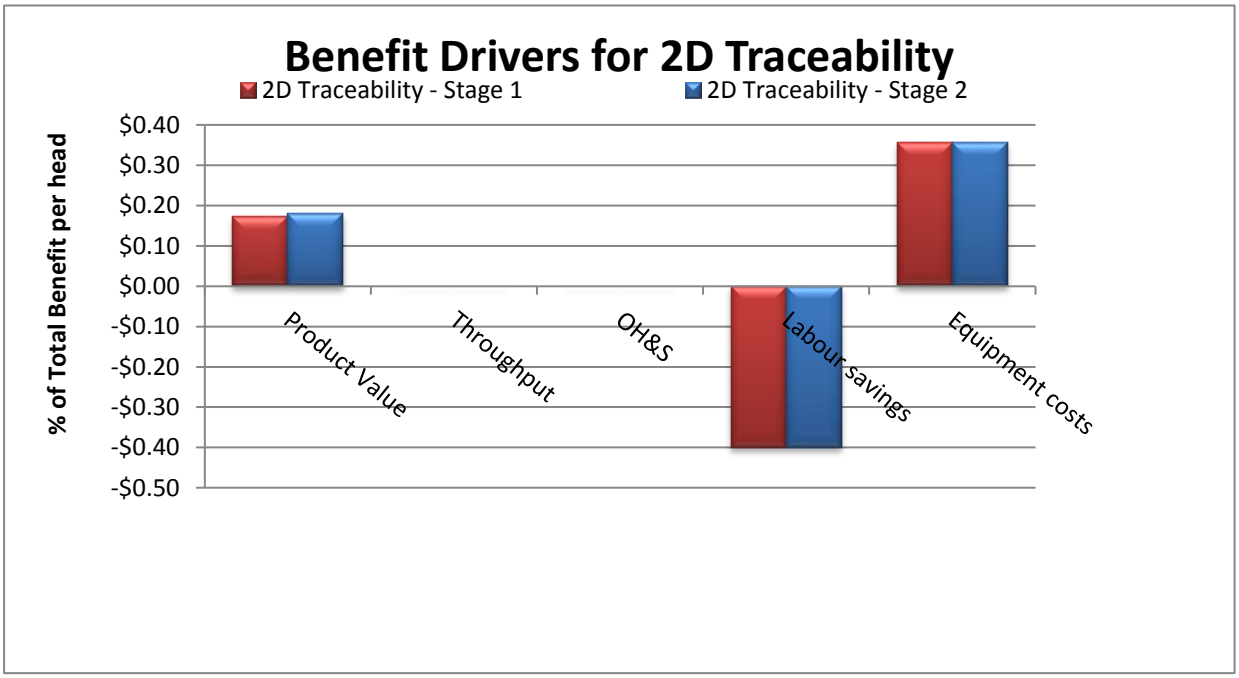

Figure 2: Summary of benefits expected to be delivered from the installation of the traceability system

Table 6: Breakdown of benefits and costs by area expected as a result of the installation of the system.

Benefit Drivers for System		
	2D Traceability - Stage 1	**2D Traceability - Stage 2**
	$/ hd	$/ hd
Processing	-$0.04	-$0.04
Product value	$0.17	$0.18
	$0.13	**$0.14**
Product Value	$0.17	$0.18
Throughput	$0.00	$0.00
OH&S	$0.00	$0.00
Labour savings	-$0.40	-$0.40
Equipment costs	$0.36	$0.36
	$0.13	**$0.14**

5.6.4 Summary Performance Measures

There is a decrease in labour productivity because of the additional increase in personnel. The quantity of head processed per annum doesn't change, but with the addition of the FTE staff member to the slaughter floor minus the decrease in workload for the QA staff, loadout supervisor and the marketing team it still results in an incremental decrease of -2.29% in labour productivity per annum, refer *table 8*. This is the same for both the stage one and stage two traceability system.

Table 7: Summary of benefits for the installation of the traceability system.

SUMMARY PERFORMANCE MEASURES		
	2D Traceability - Stage 1	2D Traceability - Stage 2
Hd / annum	109,440	109,440
Production increase with equipment	-2.29%	-2.29%

A summary of the range in costs and benefits for each scenario are included in *Table 8* below. The $0.02 difference in accuracy benefit per head is a result of the enabling capability of the proposed stage two system that enables sales optimisation.

Table 8: Ex-ante costs and benefits breakdown for the current throughput and increased throughput.

COST - BENEFIT ANALYSIS OF SYSTEM		
	2D Traceability - Stage 1	2D Traceability - Stage 2
Benefit summary	$/hd Avg.	$/hd Avg.
$ Accuracy Benefit per head	$0.34	$0.36
$ Technique Benefit per head	$0.00	$0.00
$ Labour Benefit per head	($0.40)	($0.40)
$ Overall Benefit per head	**-$0.06**	**-$0.04**
** Cost is reported as the inaccuracy from target specification OR as the difference between Manual vs. Auto costs*		
COST ASSOCIATED WITH OPERATING SYSTEM		
	$/hd	$/hd
Capital cost	$0.19	$0.19
Maintenance	$0.00	$0.00
Operation	$0.27	$0.27
Risk of mechanical failure	-$0.63	-$0.63
Total cost per head	-$0.16	-$0.16
Total cost per head (EX CAP)	-$0.36	-$0.36

5.6.5 Total Net Benefit

Table 9 shows the range in value associated with each cost of processing. The cost is calculated as any loss from the maximum potential benefit. Presenting the figures this way in the detailed section of the model demonstrates the total costs involved and highlights areas where future savings could be generated.

Table 9: Summary results of individual savings associated with lamb traceability.

TOTAL BENEFIT			
		2D Traceability - Stage 1	2D Traceability - Stage 2
Benefit summary		$/hd From	$/hd From
1. Value opportunity	Reduced Retained Carcases	$0.01	$0.03
	Value through enabling factors	$0.33	$0.33
2. Throughput benefit		$0.00	$0.00
3. OH&S benefit		$0.00	$0.00
4. Labour benefit		-$0.40	-$0.40
Equipment costs	**Maintenance**	$0.00	$0.00
	Operation	-$0.27	-$0.27
	Risk of failure	$0.63	$0.63
	$ Benefit per head	**$0.30**	**$0.32**
$ Annual Benefit overall plant		**$33,016**	**$34,901**

5.6.6 Comparative Costs Breakdown

Figure 3 shows the difference in costs 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.

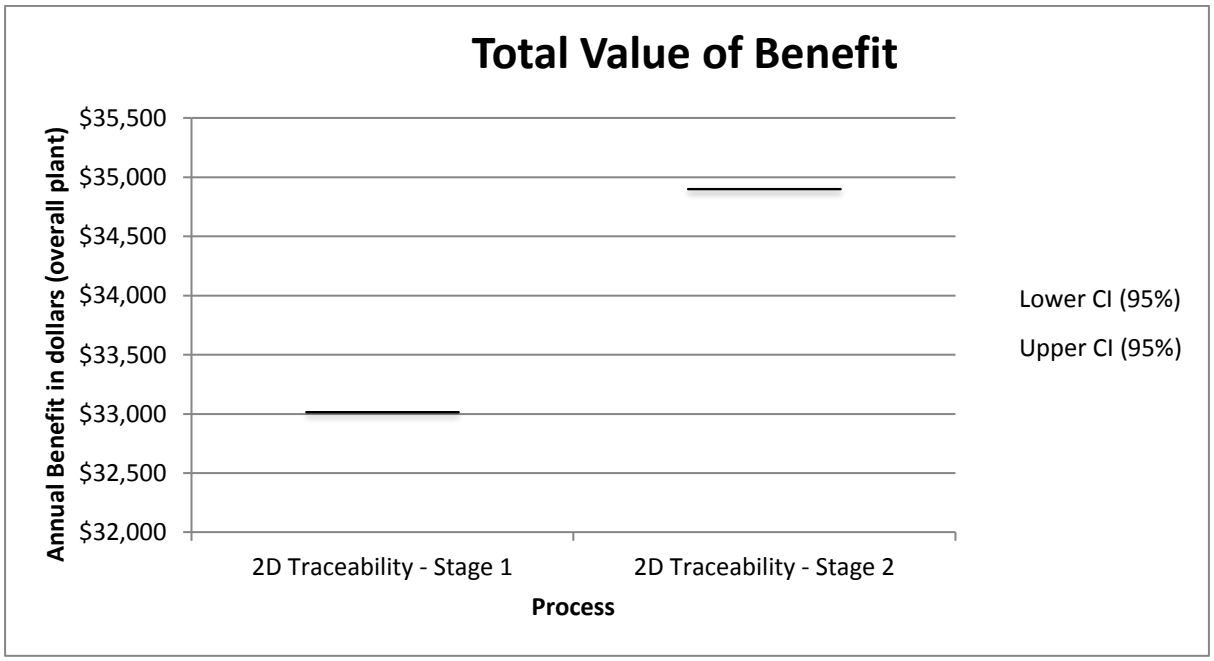

Figure 3: Graphical representation of losses captured in Table 9 showing value of the benefit expected through using the automated systems.

5.7 Comparison of 2D technology and radio-frequency identification systems

A radio-frequency identification (RFID) system is a wireless communication technology that transfers information between tagged objects and readers. It allows automatic recognition and the unique identification of every object and is a solution for individual traceability where desired.

The differences between a RFID system and 2D barcode system are:

- RFID system is more expensive than a 2D barcode system.
- RFID system saves labour because data is collected automatically using data collection points.
- There is a reduced operating cost per carcase due to longer requiring carcases tags.

It was envisioned that the 2D bar code tracking system was a traceability solution for smaller processing plants. However because of the additional labour requirements to attach carcase tangs and scan barcodes, the RFID technology is comparable and is should be investigated further. It is possible that RFID technology would have an improved return on investment than that of the 2D barcode system because of the expected labour savings. However to confirm if there is a cost benefit between a RFID system and 2D barcode system for smaller plants, further investigation would be required including confirmation about labour savings that would off-set the additional capital costs.

6 Key Findings

Compared to the manual system, the installed stage one 2D barcode traceability system and the proposed stage two 2D barcode traceability system have positive payback periods and transition Radfords from manual processes to smart technology resulting in more accurate data entry and enables individual carcase traceability and is suitable for use by the National Livestock Identification System and disease tracking. The traceability systems do not provide a significant payback period but enables growth in Radford's capability and integration of carcase data to individual animals which was not possible before.

The proposed stage two 2D traceability system has additional enabling capability of sales optimisation based on tracking of individual carcase weights which improves the return on investment. However the primary benefits are increased lean meat yield and reduced down time.

It is possible that the plant would have more benefit from a RFID system however the following factors would have limited this installation at this point are:

- The reliability of currently available RFID gambles
- The lack of carcase identification for the customer as the plant are selling all bodies as carcases

In addition to the carcase feedback system of both the existing stage one traceability system and proposed stage two traceability system, they also provide a more robust system for monitoring animal movements for disease traceability.

7 Appendix

7.1 List of Tables

7.2 List of Figures