final report

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Automatic Rack Fat Cap and Flap Removal

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Executive Summary

The process of converting rack barrels to a finished retail-ready frenched product is one of the most labour intensive and time consuming activities undertaken at Australian sheep and lamb processing facilities. Boning room staff generally remove rack caps by hand, immediately after chine and feather bone removal. An automated Fat Cap Removal Machine (FCRM), currently being developed in New Zealand by Southern Engineering Solutions (SES), was trialled in this project. The aim of the trial was to assess the potential of the automated FCRM to reduce labour costs and improve Workplace Health and Safety (WHS) and product quality / consistency.

The automated FCRM was installed in January 2016 and operated for 25,852 cycles during the trial. The average load and cycle times were estimated at 5.55 and 5.45 seconds on average, respectively. Compared with the manual fat cap removal, which takes approximately 30 seconds for a pair of racks, it was estimated that a cost saving of up to $133,000 are achievable.

While no WHS incidents associated with the FCRM, nor manual fat cap removal, occurred during the trial, the reduction in bandsaw use and of repetitive, manual, high risk tasks was considered a considerable benefit.

The FCRM does not appear to increase microbial levels on end product, although only limited microbiological test results were obtained. However, more consistent rib length has resulted in a more consistent and hence higher quality end product.

While the FCRM machine worked well for carcases with <25kg Hot Standard Carcase Weight (HSCW), it performed inadequately for carcases with ≥25kg HSCW. Furthermore, this trial has identified a range of potential design improvements that should be considered by the manufacturer.

The FCRM, even in its current form, represents a significant development toward providing an automated solution to this particular common lamb processing activity.

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1 Background

The process of converting rack barrels to a finished retail-ready frenched product is one of the most labour intensive and time consuming activities undertaken by many sheep processing plants. Rack caps are usually removed by hand, immediately after chine and feather bone removal. Depending on the plant and throughput, this operation can require approximately 30 seconds per barrel per person.

In contrast to the manual rack cap removal operation usually, an automated Fat Cap Removal Machine (FCRM) is currently being developed in New Zealand by Southern Engineering Solutions (SES)[1]. The FCRM completes the same task in approximately 8 seconds, including flap removal.

Based on schematics and processing speed ability of the FCRM it was anticipated that substantial savings could be utilised.

Further potential benefits include:

- Reduced bacterial levels on finished product
- Improved rack quality (i.e. better presentation) due to accurate automated rib length cutting
- Increased profit margin through increased prime rack production (cap off/frenched)
- Improved Workplace Health and Safety (WHS)

In addition, it may be possible to incorporate chine bone removal as part of the machine's capability, further increasing the potential benefits.

The aim of this project is to determine the machine's ability to remove the cap and flap from a lamb rack barrel under Australian conditions. A successful outcome would result in a commercial offering of the machine in Australia by SES.

2 Projective Objectives

The objectives for this project were to:

1. Install the Southern Engineering Solutions (SES) prototype Fat Cap Removal Machine that removes the flap, scapular cartilage and cap from rack saddles.
2. Evaluate the multi-faceted benefits the machine will deliver when exposed to Australian operating conditions. Evaluations will consider effects to yield, microbiological status, labour savings and OSH risk reduction.

[1] http://sesltd.co.nz/fat-cap-removal-machine.php

3 Methodology

3.1 Trial Design

The FCRM was manufactured in NZ by SES and shipped to the trial plant, where it was installed and commissioned by SES staff for use in the trial.

The FCRM was initially trialled on all grades of lambs that were feedstock for frenched racks. It soon became apparent that the machine could not cope with lambs >25kg Hot Standard Carcase Weight (HSCW) and therefore the machine was then limited to use on <25kg HSCW carcasses.

3.2 Time to perform operation / labour

Cycle and load times were measured using a stop watch on several occasions throughout the trial.

3.3 Microbiological testing

3.3.1 Sample collection

Swab samples (25 cm^2) were taken from the outer surface of the membrane encapsulating the *longissimus dorsi* muscle using the standard ESAM swab template. Five separate manually prepared racks and five automatically prepared racks, prior to water Frenching, were swabbed. The swabs were returned to the bag and 25ml Buffered Peptone Water added. Samples were transported to a NATA accredited laboratory for microbiological testing.

3.3.2 Microbiological analysis

On arrival at the laboratory the following tests were performed:

- Total Viable Count (TVC) (AS 5013.1): Incubated at 30°C+/-1°C for 72hrs +/-3hrs under aerobic conditions (Limit of detection 33 cfu/cm^2).
- Coliform Count (AOAC 991.14): Incubated at 35°C +/- 1C for 24hrs +/- 2hrs under aerobic conditions (Limit of detection 0.33 cfu/cm^2).

3.4 Workplace Health and Safety

Safety features on the FCRM were assessed and a risk assessment was prepared prior to operation.

4 Results

4.1 Installation

The FCRM arrived at the plant from New Zealand in early December 2015 (Figure 1), and was subsequently assembled in the Engineering workshop (Figure 2).

Figure 1: FCRM machine on arrival at the facility.

Figure 2: FCRM machine assembled in Engineering workshop.

A technician from SES travelled to the trial plant to set up and commission the machine for use in the trial in January 2016. The machine was strategically placed and linked into the existing lamb cutting line to expose it to commercial operating conditions. During the trial the machine completed 25,852 cycles as shown on the electronic counter (Figure 3).

Figure 3: FCRM completed operating cycles at end of trial.

4.2 Time to perform operation / labour

The FCRM had a cycle time of approximately 5.45 seconds on average, while the time taken to load the machine averaged 5.55 seconds, resulting in a production capacity of approximately 5.5 rack barrels per minute. Obviously load times can vary and depend on process implementation, particularly considering the machine and operator's proximity to the feedstock.

Operators currently undertaking the task of knifing, peeling and removing rack caps are completing a single rack every 15 seconds (excludes flap removal). It was confirmed that the introduction of a FCRM into the trial plant, when cutting < 25kg HSCW carcasses (without water frenching), could deliver a saving of two labour units combined with a reduction in classification for an additional labour unit. The associated cost saving was calculated as $133,000 p.a. per shift (assumed labour unit cost of $65,000 p.a. per shift). This outcome includes the requirements to no longer manually separate the flap from the rack barrel and the intermediate step to further process the rack between chine removal and Frenching (Figure 4).

Figure 4: Racks on the left show the outcome following the use of the FCRM and chine bone removal machine. Racks on the right show the outcome of the manual intermediary step between chine bone removal and water frenching.

Based on schematics and processing speed ability of the machine it was originally estimated that a processor would increase cap off rack production by 32.2%.

However, when installed in the trial plant, proximity to feedstock extended the cycle times of the machine operation and therefore reduced the savings. Careful incorporation into an existing process and /or following the recommendations in this report with regard to control orientation would definitely result in an overall reduction in cycle times experienced at the trial plant and hence improve the saving potential.

4.3 Microbiological results

The microbiological test results are shown in Table 1. Based on these results there does not appear to be a difference in the microbiological quality between manually and automatically capping.

Table 1: Microbiological test results

	Manual		FCRM	
Sample	TVC[a]	Coliforms[a]	TVC[a]	Coliforms[a]
1	<33	<0.33	<33	<0.33
2	<33	<0.33	<33	<0.33
3	<33	<0.33	<33	<0.33
4	<33	<0.33	66	<0.33
5	<33	0.33	<33	<0.33

4.4 Workplace Health and Safety

The FCRM safety features include:

- A hand and a knee operated emergency stop button positioned at the operator end of the machine;
- Two separate additional emergency stop buttons positioned on both sides of the machine at the exit end;
- The operating aspects of the machine are completely enclosed to eliminate projectile type hazards;
- Access to the working parts of the machine is prevented by four interlocking panels that stop the machine on opening; and
- The main on/off switch contains provision for it to be physically locked if required.

There were no injuries recorded during the trial period involving the use of the FCRM nor the manual activities of band-sawing and converting rack barrels to finished frenched racks.

5 Discussion

The FCRM was very effective on lambs <25kg HSCW, irrespective of Fat Score. While specific yield measurements were not collected during the trial, the yield outcome of the rack component was no different to manual fat cap removal. However, the more consistent cutting approach of the flap removal could have an effect on flap recovery yield, though this aspect was not measured as part of the trial as the focus was on fat cap removal and the issues that subsequently presented with this primary activity. During this trial it was also noted that the intermuscular fat displayed a “prickled” effect after the FCRM removed the cap, however, this did not have any deleterious effect to the presentation of the finished rack product once vacuum packed.

However, the FCRMs effectiveness can be compromised by dressing damage over the scapular section of the rack barrel or by the inaccurate separation of the forequarter from the rack barrel. Nevertheless, once adjusted and using undamaged barrels, the separation of the flap from the rack was consistently precise and the resulting product presentation was to a satisfactory standard. However, the adjustment mechanism using the fly-wheel provided was slow and cumbersome and commercially unsuitable. The overall reliability of the FCRM was not assessed in a controlled trial, though the only malfunctions on <25kg animals were due to dressing damage or incorrect cutting lines.

In contrast, the FCRM did not perform well on lamb carcasses in excess of 25kg HSCW. The following design shortcomings were identified:

- The gripping and associated ram system was undersized for carcasses in excess of 25kg HSCW, resulting in fat caps not being completely removed.
- The saw motors were underpowered to complete the cutting cycle effectively. This resulted in:
  - Blade burring damage with the serrated tip of the cutting edge rolling over (Figure 5).
  - Rib shatter on both the flap and rack (Figure 6).
  - Lack of separation of the flap from the rack (Figure 7).
  - Distortion of the rack barrel (Figure 8).

Figure 5: Cutting blade burring damage

Figure 6: Rib damage

Figure 7: Incomplete separation of the flap from the rack

Figure 8: Distortion of the rack barrel

The machine was designed to provide easy access for cleaning and sanitation. However, a number of general design flaws were observed during the trial, including:

- Gripper assembly pivot points require an alternative fastening design as circlips were dislodged during its operation (Figure 9).
- The gripper assembly loosened during machine use.
- The electrical cable conduit was poorly positioned and was subject to entanglement and subsequent damage (Figure 10).
- A poor flap and rack cap discharge design resulted in product accumulation within the machine (Figure 11).
- The FCRM was manufactured from materials which corroded rapidly in some instances and consequently are unsuitable for the meat processing environment (Figure 12).

Figure 9: Dislodged circlip

Figure 10: Damaged electrical cable conduit

Figure 11: Accumulation of rack caps and flaps

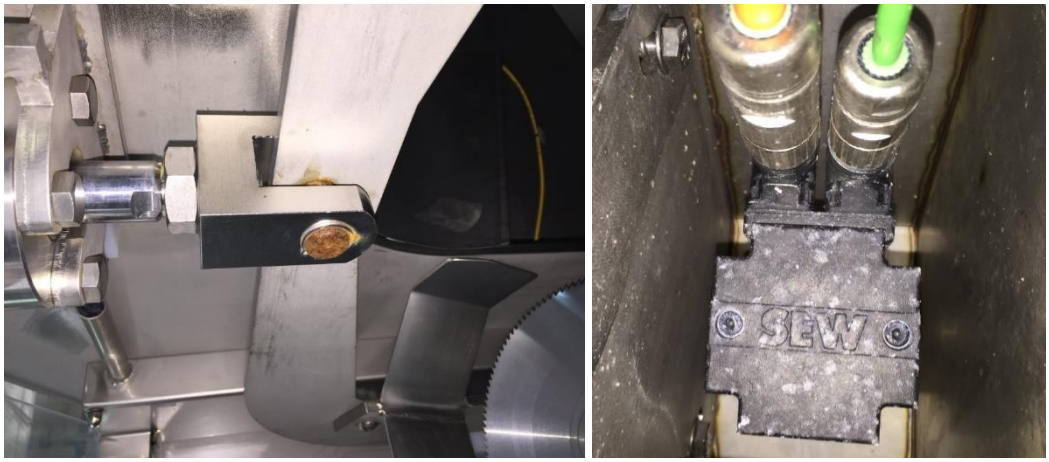

Figure 12: Corrosion of parts

While the FCRM was user friendly and easy to operate, operators were unable to view the machines cycle, which was a disadvantage, especially when problems occurred during the cycle. Furthermore, a more flexible / adjustable operator control console, compared with the current fixed position design, could further assist in reducing load times.

The mechanics of the machine were relatively simple and its design provided ease of access from an engineering, repair and maintenance perspective.

The safety systems incorporated in the machine, in the trial company's view, were adequate and in line with Australian Standards. A fully functional machine eliminates the need to remove the flap from the rack barrel, which traditionally has been removed by bandsaw, and as such is a high risk manual operation. The machine also removes the repetitive task of removing the rack cap which is currently removed by hand or in certain circumstances assisted by the use of a jig. No injuries associated with the use of the machine, nor with manual fat cap and flap removal, were recorded during the trial. However, the ongoing curtailment of repetitive, manual, high risk tasks for the industry must translate to reductions in injuries and associated costs.

The FCRM was conceptually sound, but clearly requires modifications, especially if it is to cope with the larger Australian lambs. In addition, a "one pass" mechanism could improve cycle times and in turn productivity benefits. This may also improve the cost of manufacture of the machine and likelihood of incorporation into a more complete entire middle solution.

6 Conclusions / Recommendations

Based on the findings from this trial it is evident that the FCRM is capable of removing the cap and flap from a lamb rack barrel for carcases with <25kg HSCW. However, it was inadequate for performing this task for larger carcases.

It is recommended that the manufacturer modify the machine to deal with larger carcases, which are common under Australian conditions. In addition, several design and build improvements that have been suggested should be considered prior to providing a commercial offering.

Nevertheless, the FCRM in its current form represents a significant development toward providing an automated solution to this particular common lamb processing activity.

7 Key Messages

- Fat Cap Removal Machine (FCRM) works well for carcases with <25kg HSCW, but not for larger carcases.
- FCRM can achieve cost savings of up to $133,000 p.a. per shift in the trial facility.
- FCRM reduces risk of bandsaw related injuries, as well as injuries associated with manual rack cap removal.
- Several general design and build improvements should be made.