final report

Project code: P.PSH.0691

Prepared by: Joanne Galletly
Top Cut Foods Pty Ltd

Date published: 16 October 2015

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

SmartShaped Beef

This is an MLA Donor Company funded project.

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.

Abstract

Top Cut Foods produces portion controlled meat products for various food service markets. There is growing demand in these markets for a natural whole muscle steak or roast meat portion that is of consistent shape, weight and can be presented as an affordable premium product. SmartShape is an innovation developed by Meat and Livestock Australia that delivers whole muscle portions with consistent circumference. Trials were carried out by Top Cut Foods SmartShaping eye of rumps and striploins for steaks and topsides and outside flats for cooked roast portions. Trial results showed improvements in yield for SmartShaped steaks eye of rump steaks and roast meat portions. Limitations with implementing a SmartShape process using this machine however are the low throughputs and inability to put various raw material sizes through the machine at one time. The calculated return on investment (ROI) when using the machine for the production of eye of rump steaks and at current volumes was poor. Further trials using commercial volumes would validate the data and cost benefit analyses reported from these trials.

Executive Summary

Top Cut Foods produces portion controlled meat products for various markets including food service, hotels, cafes, restaurants and plated meals. There is growing demand in these markets for a natural whole muscle steak or roast meat portion that is of consistent shape and weight and can be presented as an affordable premium product. SmartShape is an innovation developed by Meat and Livestock Australia that delivers whole muscle portions with consistent circumference. The reported benefits of this technology include a reduction in trimming yield loss and an improvement in portion shape consistency.

Competitive pricing, convenience, portion control and nutritional care have increased the appeal of prepared meals especially in the area of weight loss and diet control. Top Cut Foods currently services a customer in this sector that requires a cooked rump steak portion with strict shape and weight specifications. These specifications cause significant yield losses and processing difficulties. SmartShape technology was assessed in these trials as a method to improve the yield of this product.

As Quick Service Restaurants (QSR's) move to compete with the rapidly growing fast casual dining sector, the fast food focus is shifting to real food options. Several Australian QSR's are seeking whole muscle, real food options in the form of a beef steak. Operationally QSR's are not equipped to produce restaurant quality steaks and therefore portion control and product consistency are key to the success of a whole muscle product in this market. In this project SmartShape technology was assessed as a method to produce a steak of consistent portion weight, size and thickness.

A retail market assessment performed during this project highlighted a lack of whole muscle beef options in the plated frozen meal market. With the plated meal capabilities at Simplot and the cooked/chill abilities of Caterfare there is potential for Top Cut Foods to supply portion controlled whole muscle meats using SmartShape technology. Portion control and slow cooking secondary meat cuts can also assist with controlling the costs of providing nutritious food to the Aged Care sector.

The trials detailed in this report assessed different meat cuts and final plated options with the intention to add value to current and potential products across various established and emerging markets. The trials focused on eye of rump steaks for a current customer, striploin steaks as a potential offering for a QSR and topside and outside flat roast portions as an alternative premium option in the plated meals market.

Using a loan SmartShape machine from Meat and Livestock Australia, trimmed eye of rump portions were SmartShaped and held in refrigerated conditions. The hold conditions varied between 1.5 hours and 18 hours to determine whether time was a factor in the development of a consistent shape. Results showed that time was a factor and the 18 hour held samples gave more consistent shape dimensions. There was an improvement in yield between SmartShaped and control samples, with significant gains found at trimming and slicing. SmartShaped portions better met the tight customer specifications.

Beef striploins were trimmed and SmartShaped to assess their viability for QSR sandwich steaks. An entire 1 rib striploin was too long to fit in the SmartShape machine and had to be cut in half laterally. Initial results showed the cranial end of the striploin produced a consistent shaped log however after being held in refrigerated conditions for 48 hours and

then being removed from the SmartShape bag returned to its initial shape within 5 minutes. The caudal end of the striploin containing the gluteus muscle folded in on itself during SmartShaping due to its flat shape and was therefore not able to be portioned. Due to the folding over of the caudal end of the striploin and the reversion of the striploin to its natural shape it was determined SmartShaping was not a suitable method to produce a portion controlled QSR steak.

Several beef cuts were considered for the trial of SmartShaped roast meat portions including knuckle and bolar blade. These two cuts however contain many muscles that have varying muscle fibre directions. The trimming required to prepare a bolar blade resulted in a 40% yield loss. Final cuts selected for roast beef trials included topside and outside flat. The topside with the cap removed required minimal trimming and resulted in a 4% yield loss at this stage. SmartShaped portions were cooked in the SmartShaped bags resulting in uniform cooked logs that allowed for consistent sliced portions. Control samples on the other hand were oddly shaped after cooking which caused inconsistent shaped portions at slicing. The topside portions resulted in the best overall yield of 66% with the cooking yield loss removed. The outside flat had an overall yield of 53%.

A cost benefit analysis carried out by Greenleaf Enterprises that focused on the current eye of rump steak volume found the ROI to be poor although it did provide a benefit of $1.60 per kilogram due to yield improvement. The total net benefit however was much less when taking into account costs such as capital, labour, consumables and repairs and maintenance. The expected payback period using the information collected during the trials was 26.9months. This figure improves significantly if volumes were increased due to new products and at full utilisation would see a payback period of 15.9 months. A change to the current process flow for the eye of rump product would also assist in improving yield however the proposed changes are not currently possible at the Caterfare plant.

The SmartShape equipment was straight forward to use and had a small footprint. The machine used in these trials was an early version and did not have an automatic bagging function which meant the process of putting a bag on the bag holder was cumbersome. Other issues identified with the technology included portions needing to be relatively uniform in shape. Larger portions would not fit through the bag holder and needed to be trimmed further and smaller portions did not shape adequately. The process is also manually intensive and limited in regards to throughputs with only 4 portions able to be SmartShaped per minute, assuming the operator keeps with the machine speed.

The results from these trials suggest the SmartShape technology delivers a consistently shaped portion and therefore a better portion controlled product. Primals with many muscle groups and different muscle fibre directions are generally not suitable for SmartShaping and therefore the technology may be limited to a few select products. Further trials using commercial volumes would validate the data presented in this report.

Table of Contents

1 Background

1.1 Market Analysis

Top Cut Foods produce a range of whole muscle beef portions for airlines, hotels, restaurants and cafes (HORECA's) and customers that produce plated meals. These cuts include but are not limited to striploins, eye of rump medallions and bonded tenderloins. An analysis was carried out on these markets.

1.1.1 Bonded Tenderloins

Tenderloin bonding uses a proteolytic enzyme to bind the tail portion to the head of the tenderloin resulting in a relatively uniform log. Customer meal preparation requires uniform cook times and as a consequence the tenderloin steaks need to be produced to strict specifications. The current process for producing 'shaped' tenderloins is manual and the consistency of the portion shape variable at times.

SmartShape has the potential to produce consistently shaped bonded beef tenderloins. A study by the CSIRO showed that cold set bound tenderloins withstood the pressure of SmartShape and produced portion controlled logs suitable for slicing into even portions (McPhail et al, 2011). The resulting product may be of premium quality and therefore offer further market opportunities both domestically and overseas.

1.1.2 Plated Meals

Competitive pricing, convenience, portion control and nutritional care have increased the appeal of prepared meals especially in the area of weight loss and diet control. Various customers purchase eye of rump medallions from Top Cut Foods. The steak dimensions can be tightly specified causing significant processing yield loss and are therefore priced at a premium.

Aged care is another sector that consumes significant quantities of plated meals. Studies suggest people in Aged Care want traditional home style cooking and baby boomers will be putting more emphasis on nutritious, tasty food (Evans, 2013). Celebrity chefs such as Maggie Beer have set up foundations to campaign for better meal options in Aged Care. Portion control and slow cooking secondary meat cuts can assist with controlling the costs of providing nutritious food in the Aged Care sector.

1.1.3 Quick Service Restaurants and Fast Casual Dining

As Quick Service Restaurants (QSR's) move to compete with the rapidly growing fast casual dining sector, the fast food focus is shifting to real food options. This is a significant change from providing cheap food of perceived poor quality and nutritional value. Fast casual restaurants generally provide more customised, freshly prepared, higher quality food whilst dining in an up scaled and inviting environment.

Several Australian QSR's are seeking whole muscle, real food options in the form of a beef 'steak'. There are issues with providing a whole muscle steak to QSR customers. A consumer would generally not be prepared to pay for a higher quality trimmed meat cut such as a striploin nor would they accept a low quality non 'steak' meat cut at a cheaper price. Operationally QSR's are also not equipped to produce restaurant quality steaks and therefore portion control and product consistency are key to the success of a whole muscle product in this market.

1.1.4 Retail Meats

Table 1 of appendix 9.1 presents a summary of a sample of chilled and frozen plated meals where beef was presented as the protein portion. These meals were available in Woolworths and Coles. The frozen meals were the least expensive and offered re-formed beef steaks as ‘roast beef’. Although re-formed beef allows for the use of cheaper cuts and provides greater portion control, the end product is of lesser quality and does not represent a natural beef cut. Of the chilled meals the Emily’s kitchen steak had the best eating quality. The Emily’s Kitchen steak visually represented a restaurant quality steak and had been sous vide cooked. The Coles brand Cuisine meal also offered a natural piece of beef but it had poor texture and contained excess subcutaneous fat and connective tissue. In this case chuck was the beef cut used. The market assessment highlights a lack of whole muscle beef options in the retail plated frozen meal market.

2 Project Objectives

The objective of this project is for Top Cut Foods to complete product concept trials using SmartShape methodology. These trials will assess different meat cuts and final plated options with the intention to add value to current and potential products across various established and emerging markets.

The following key outcomes will be delivered:

1. Review of HORECA/QSR sandwich steak and cooked sliced roast beef market. Identify whole shaped muscle requirements, product specifications and quantify the market opportunity.
2. Top Cut to advise Fix All services prescribed target dimensions.
3. Fix All to fabricate and supply 'ring' sizes and train Top Cut operational staff to operate MLA demonstration unit.
4. Top Cut to produce proof of concept products under commercial conditions and determine specifications, yields and costs for market evaluation, including:
   - Raw sandwich steak cut through Marel I-cut
   - Sous vide cooked beef for ready to heat/eat meat plating
5. Market and consumer validation of the product concepts in terms of flavour, mouth feel, food safety and acceptability.
6. Third party (Greenleaf) cost benefit analysis study on the above criteria.
7. A report with recommendation as the commercial viability of the technology platform with the Simplot/Top Cut business, including cost benefit analysis.

3 Methodology

3.1 Equipment

The SmartShape machine used in these trials was on loan from Meat and Livestock Australia. The machine was an early version and had been serviced by Arthur Pitt of Fixall Services prior to the start of trials. Fixall services also provided training on the operation of the SmartShape system that covered safety, manual and automatic modes, changing of the rubber inserts, meat shaping and packing and cleaning of the machine.

The bags and bag holders used in these trials were received with the machine. Bags were manufactured by Oppenheimer and ranged in circumference from 220mm to 260mm. Early trials indicated the bag holders supplied with the machine were suitable for the cuts assessed in the below trials.

During early trials the machine settings were assessed. The final settings used in the trials were:

Chamber pressure: 85Kpa
Grip: 50s
Initial size: -40Kpa

3.2 Eye of Rump Steaks

3.2.1 Trial 1

The purpose of trial 1 was to understand the yield loss associated with trimming, portion cutting, marinating and cooking SmartShaped eye of rump portions.

Six *S* rostbiff's (3 muscle) were passed through a Ross Tenderiser and then trimmed of the undercut (M gluteus profundus and M gluteus accessories), fat and external connective tissue. The internal seam was removed and the remaining portion cut in half giving a total of three portions. These portions were SmartShaped using the 70mm bag holder and 220mm bag. Bags were tied with metal clips and samples were stored for 18 hours in 2°C refrigeration.

The following day a further six rostbiff's were trimmed as per the above procedure. Three rostbiff's were SmartShaped and stored for 1.5 hours at 2°C. The control samples were further trimmed to a cylindrical shape and held for 1 hour at 2°C. There were three main treatments groups as listed below.

SmartShaped, 18 hour hold (SS 18hr hold)
SmartShaped, 1.5 hour hold (SS 1.5hr hold)
Not SmartShaped (No SS)

Packaging was removed from all SmartShaped samples and after dimension data was collected samples were placed through a Marelec portion cutting machine on a 120g setting.

Half of the sliced portions from each of the three groups (SS 18hr, SS 1.5hr and No SS) were separately tumbled for 5 minutes in marinade at 15% inclusion. All marinated and non-marinated samples were then evenly spaced into cook stable cryovac bags and vacuum

sealed. Samples were cooked in a Vemag Mauting industrial oven with steam at 64°C for a pre-determined period of time. After cooking, samples were cooled to 1°C in a blast chiller and stored at 1°C for 48 hours prior to final assessment.

3.2.2 Trial 2

The purpose of trial 2 was to assess whether crust freezing SmartShaped samples gave better shape consistency during portion cutting and to add a face cut step to the portion cutting process to reduce the yield loss observed in trial 1.

Three rostbiff's were prepared as per the trimming procedure detailed in trial 1. All samples were SmartShaped and held for 18 hours at 2°C. Samples were then placed in a freezer at -18°C to crust freeze. After 3 hours, samples were removed and were allowed to temper at 7°C for 30 minutes. Samples were then placed through the Marelec portion cutting machine on a 120g setting with a face cut parameter of 10mm.

3.3 Striploin – Sandwich Steak

An initial trial was carried out using a *YG* 1 rib beef striploin. The striploin was trimmed of all fat, chain and gluteus muscles and connective tissue. The trimmed striploin was cut in half laterally and SmartShaped in bags with a 286mm circumference. The samples were stored in a 2°C refrigerated chiller for 48 hours. After holding, the samples were removed from the SmartShape packaging and placed through the Marelec portion cutting machine on a 10mm setting.

The second trial involved trimming a *YP* 1 rib grain fed striploin and a *PR* 3 rib striploin, of external fat and removal of the chain muscle. The silver skin was larder trimmed as per the image below. The purpose of maintaining the silverskin was to assist with the integrity of the striploin eye muscle during SmartShaping and to also reduce yield loss. In trial 1 where the silverskin had been removed the result was misshapen striploins and sloppy portion cut steaks.

Image 3: Larder trimmed striploin

The striploins were cut in half laterally and SmartShaped into bags with a 290mm circumference. The ends of the bags were tied with string. The samples were stored in a 2°C refrigerated chiller for 24 hours. After storage, packaging was removed from each sample and dimensions were measured. The samples were then placed through a Marelec portion cutter on a 110g setting.

3.4 Roasts – Topsides and Outside Flats

Two *YG* beef topside cap off primals were removed from vacuum packaging and trimmed of fat and connective tissue. One primal was injected with a meat brine at 15% and held for 1.5 hours. Both primals were cut into portions parallel to the muscle fibre direction. Portions were separated into treatment groups as per Table 1. SmartShaped portions were SmartShaped using the small rubber and either a 140mm or 160mm circumference bag. Samples were held for 12 hours at 2°C then vacuum packed. All samples were cooked in a steam oven and held at an internal temperature of 72°C for one hour. Post cooking, samples were blast chilled then stored for 3 days at 1°C. Post-cooking analysis required samples to be weighed before and after removal from packaging. Samples were then cut using a Trief slicer on a 10mm setting.

The processes described above were carried out for three *A* beef outside flats. The sample plan below indicates the treatment groups and number of samples for each of the primals.

Table 1: Treatment groups for topside and outside flat roast trials

	Number of primals	Treatments	Number of samples
Topside	2	SS Injected	2
		Control Injected	2
		SS not injected	3
		Control not injected	3
Outside Flat	3	SS Injected	4
		SS not injected	2
		Control not injected	4

SS = SmartShaped

4 Results and Discussion

4.1 Eye of Rump Steaks

4.1.1 Trim Yield

Table 2 shows the yield loss due to removing the undercut, centre seam and trimming excessive fat and connective tissue from the outside of the rostbiff. Trim is separated from fat waste as it is used in further processing to produce mince. The yield loss due to preparing a rostbiff for eye of rump steaks is 31%.

Table 2: Rostbiff trimming yield

n=12	Mean	s.d.	Minimum	Maximum
Initial weight (g)	3787	498	3025	4522
Undercut (g)	441	54	330	508
Fat waste (g)	403	151	216	641
Trim (g)	330	114	136	533
Initial trim yield loss (%)	31%	4%	23%	37%

Post trimming, the rostbiff was cut into two further portions yielding three portions per rostbiff. Images 3 and 4 show the portions ready for SmartShaping and portions that had been further cylindrical trimmed respectively. Table 3 presents the average percentage yield loss for a rostbiff and the further yield loss as a result of trimming the three portions to a cylindrical shape.

Image 3: Initial trim and portions

Image 4: Portions further trimmed to cylindrical shape

Table 3: Trimming yield loss

	SmartShaped	Non-SmartShaped
Undercut (% of rostbiff yield loss)	11.7%	
Fat waste (% of rostbiff yield loss)	10.6%	
Trim (% of rostbiff yield loss)	8.7%	
Further trim to cylindrical shape	nil	12.8%
Total trimming yield loss (%)	31%	44%

In this trial, the extra trimming required to produce an evenly shaped portion for steak cutting added a further 13% loss in yield. The undercut accounted for 11.7% of the yield loss for a three muscle rostbiff.

4.1.2 Further Processing Yield Loss

Table 4 presents the total yield loss before cooking including portion cutting losses and taking into account the addition and uptake of marinade.

Table 4: Further processing yield

	Total yield loss
SS 18hr hold	33%
SS 1.5hr hold	36%
No SS	56%

Yield loss was analysed based on customer specification. Assessments after portion cutting showed some steaks did not meet the processing thickness and weight specifications. Steaks not meeting the specifications were removed from further processing. As can be expected the majority of underweight or overweight steaks also did not meet the thickness requirements.

In trial 2 it was found that crust freezing was not successful due to the flat conveyor on Marelec portion cutting machine. When the knife hit the crust frozen portions, steaks were tossed from the conveyor and the orientation of the portion altered causing steaks to be cut on the diagonal. Using a v-shaped conveyor may assist with maintaining the orientation of the portion.

The calculated average marination uptake for the three treatment groups was between 10-12%. After marination the final yield loss for the SS 18hr hold group was 33%. This is compared to the No SS group that lost 56% yield throughout the process. It was observed after tumbling that the SmartShaped steaks lost shape integrity. Some steaks were not usable and were removed from the trial. Unfortunately the percent loss was not measured. This issue was less apparent with the non SmartShaped steaks.

Most customers receive the steaks in cook bags containing the cooked meat exudate. The marinade used in this trial contained corn flour and salt. These constituents assisted with some moisture retention in the steaks. This is shown in Table 5 by the difference in cook yield loss of ~19% between marinated and non-marinated steaks. The difference in cooking loss between the non-marinated SmartShaped steaks and the non-marinated non-SmartShaped portions was ~15%. This could be due to the SmartShape process disrupting the myofibrillar proteins causing extra drip loss.

It was found that non-marinated steaks, after removing the cooking exudate, were not within the customer weight specification.

Table 5: Cooking yield loss

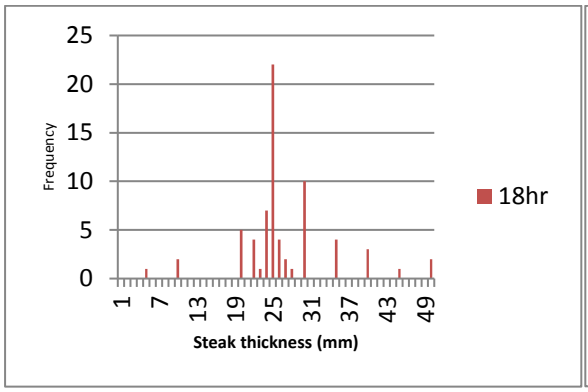
	Yield loss (% of portion weight)
SS 18hr hold marinated	7.1%
SS 1.5hr hold marinated	9.4%
No SS marinated	9.3%
SS 18hr hold no marination	26.8%
SS 1.5hr hold no marination	25.4%
No SS no marination	11.0%

4.1.3 Steak Dimensions

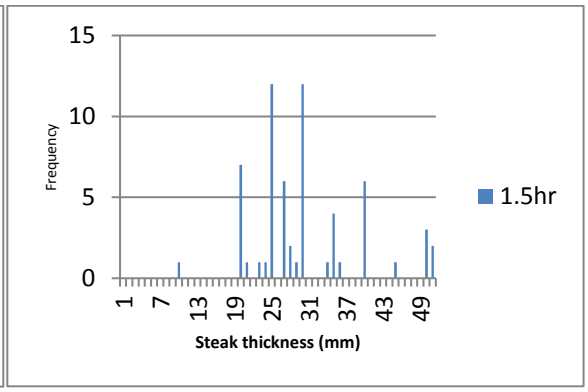
The dimensions of raw steaks and cooked steaks were measured after portion cutting. The Marelec portion cutter can be set to cut to either a weight or thickness. Early trials indicated a weight setting gave better thickness and weight consistency.

a) Steak Thickness

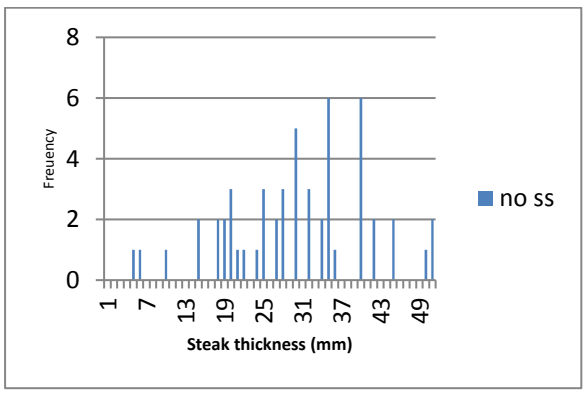
The histograms below present the range of raw steak thicknesses measured for each of the groups. The SS 18hr hold group had the least variation and presented a normal distribution. The No SS group had the largest steak thickness variance. This suggests the consistency in the log shape of the SmartShaped portions gives better steak thickness consistency.



Histogram 1: Steak thickness SS 18hr hold



Histogram 2: Steak thickness SS 1.5hr hold



Histogram 3: Steak thickness No SS

The average steak thickness post cooking was 17mm and ranged between 14 and 19mm for the treatment groups. Images 5 and 6 show a non-SmartShaped portion cut log and a SmartShaped log held for 18 hours respectively. Image 5 highlights the improvement in steak thickness consistency due to SmartShaping.

Image 5: Non-SmartShaped log portion cut

Image 6: SmartShaped (18hr hold) log portion cut

b) Steak Width

Table 6 presents the average steak width for each treatment group as a raw steak, marinated and cooked steak, and non-marinated and cooked steak.

All raw steaks were within the specification, however for cooked steaks only the SS 18hr marinated and cooked steaks were within the specification. The SS 18hr steaks also had the least variance. The variance was less for cooked steaks compared to raw. The No SS average cooked steak width was not within the specification. These results suggest SmartShaping and holding for 18 hours gives a more consistent steak width.

Table 6: Eye width of raw, marinated and cooked steaks

	Raw		Marinated Cooked		Not Marinated Cooked	
	Average (mm)	s.d. (mm)	Average (mm)	s.d. (mm)	Average (mm)	s.d. (mm)
SS 18hr hold	82	13	89	2	92	7
SS 1.5hr hold	84	15	93	10	94	13
No SS	79	18	98	7	107	9

Images 7 and 8 below visually present the difference in steak shape for' non SmartShaped cooked steaks' and 'SmartShaped held for 18 hours cooked steaks' respectively.

Image 7: Non-SmartShaped cooked steaks.

Image 8: SmartShaped 18hr hold cooked steaks.

4.1.4 Throughputs

The SmartShape manufacturer advised the throughputs for medium sized portions were:

- Manual mode: 3 portions/min
- Automatic mode: 4 portions/min

The average rump portion weight ready for SmartShaping was 870g. When taking into account some stoppages on an 8 hour shift the throughput on manual mode for rump portions will be approximately 1MT/shift.

4.2 Striploin

The Quick Service Restaurant (QSR) industry is placing an emphasis on 'real food'. Various QSR's have expressed interest in offering a steak sandwich as part of their main menu. Traditional steak sandwiches are made using rib eye or striploin. Beef striploin is a relatively uniform muscle with little inter-muscular connective tissue and was therefore considered a potential portion controlled steak for a QSR steak sandwich offering.

In the first trial a *YG* 1 rib striploin was trimmed of fat, connective tissue and the gluteus medius and chain muscles. The associated yield loss was 51%. The striploin was too long for the SmartShape machine and had to be cut in half laterally. The caudal end with the gluteus medius removed was too thin and folded over during the SmartShape process. The steaks cut through the Marelec portion cutter machine were sloppy and misshapen.

The second trial assessed a *YP* 1 rib striploin and *PR* 3 rib striploin. The purpose of the second trial was to assess the integrity of the striploin during SmartShaping with the gluteus medius muscle retained. The striploins were trimmed of fat but the top silverskin layer was retained and larder trimmed. The resulting yield loss was 24% and 37% for the 1 rib and 3 rib striploins respectively.

Post the holding period the striploin portions were removed from the SmartShape packaging. As per the previous trial the caudal end of each of the striploins had folded over during SmartShaping. Images 9 and 10 show a non-gluteus (cranial) end portion in SmartShape packaging and the same portion after being removed from SmartShape packaging post holding respectively. Once removed from packaging the striploins returned to their pre-SmartShaping shape within approximately 5 minutes. Image 11 shows a SmartShaped non-gluteus (cranial) end portion that had been placed through the Marelec and portioned. The

image highlights how the muscle returned to shape post SmartShaping. Images 12 and 13 show a gluteus end portion that had been removed from SmartShape packaging. Note how the muscle folded in during the SmartShape process.

Image 9: Striploin portion in SmartShape bag

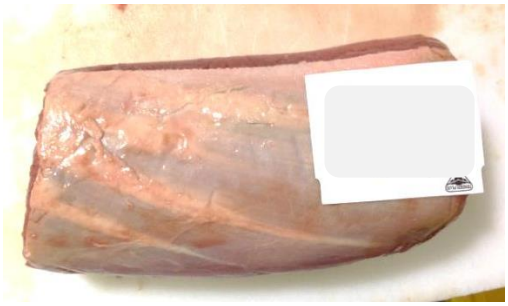
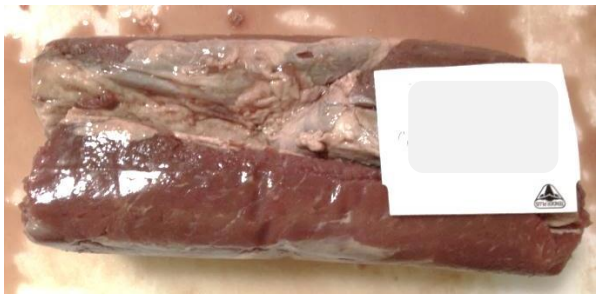


Image 10: Non-gluteus portion post holding

Image 11: SmartShape striploin (trial 2) portioned using Marelec. Note the portion has returned to its pre-SmartShape shape.



Images 12 and 13: Striploin (caudal end) portion post holding. Note how the muscle has folded in.

Due to the folding over of the caudal end of the striploin during SmartShaping and the reversion of the striploin to its initial shape, it is suggested SmartShaping is not a suitable shaping method to produce a portion controlled QSR striploin steak.

4.3 Roasts

4.3.1 Cuts Trialled

Cuts considered for this trial included beef topside, knuckle, bolar blade and lamb leg.

Beef knuckle was removed from consideration due to the different muscle fibre directions within the cut. Early trials highlighted the same issue for beef bolar blade. The quantity of

trimming required to isolate the main muscle (40% yield loss) determined the bolar blade was not suitable as a SmartShaped roast beef product.

Beef eye round was also trialled initially however during cooking the cut reverted to its natural shape which is already of a reasonably consistent diameter. Due to this beef eye round was also removed from consideration.

Tunnel and slash boned lamb legs were assessed for their suitability for SmartShaping. An entire tunnel boned lamb leg was SmartShaped but was too large for the 100mm (largest) bag holder. The slash boned lamb leg was cut in half and SmartShaped. Due to the number of muscle groups in a lamb leg the portion rolled in on itself which meant SmartShaping was not a suitable processing method. There may be potential for using a protein binder such as transglutaminase to bind the lamb muscles together to produce a SmartShaped lamb leg log.

The cuts assessed in final trials were beef outside flats and topsides. These cuts were selected due to consistent muscle fibre direction throughout the main muscle groups.

4.3.2 Yields

There were four different treatment groups for the topside trials and three for the outside flat trials. The SS injected and control injected samples were obtained from the same topside primal. A second topside primal was used for the non-injected samples.

4.3.3 Topside Yield

As presented in Table 7 the initial average trim loss for the two primals was 4%. The topsides used in these trials were cap off and therefore there was little fat or connective tissue to trim. During initial portion cutting, a round shaped side portion was produced. This section, which was not suitable for SmartShaping, accounted for 10% of the primal and was included in the total average initial trim loss of 14%. This portion however could be used as a small round roast or be used in mince or diced beef.

Table 7: Yield results for roast beef topside and outside flat portions

	Topside	**Outside Flat**
Initial trim yield loss	4%	21%
Trim yield loss including removal side portion (TS) and side muscle (OF)	14%	38%
Brine uptake (injected portions)	6%	7%
Average Cooking liquid loss (% of portion weight)		
SS injected	28%	35%
Control injected	31%	Not sampled
SS not injected	28%	32%
Control not injected	31%	32%
Total Average Yield (finished sliced product not including cook liquid)		

SS injected	66%	53%
Control injected	0%	Not sampled
SS not injected	57%	43%*
Control not injected	43%	50%

*further yield loss due to trimming at SmartShape machine to fit portions through bag holder.

The cooking yield loss was calculated from the portion weight, post injecting and SmartShaping. I.e. the weight of the portion after removing cooking liquid divided by the portion weight prior to cooking. The results suggest SmartShaping improved the cooking yield by 3%. Both SmartShaped treatment groups lost 28% yield due to cooking loss compared to the control groups 31%. There was no difference in the cooking yield loss between the injected and not injected samples.

SmartShaping improved the total finished product yield due to shape consistency during slicing. The best yield was 66% for the injected SmartShaped portions. The control injected portions did not produce any sliced portions suitable to present as a roast slice. Images 14 and 15 show portions from the control injected treatment group. The presentation of the SmartShaped portions when sliced, were aesthetically acceptable as highlighted in Image 17.

Image 14: Non-SmartShaped cooked topside portion portion

Image 15: Sliced non-SmartShaped cooked topside

Image 16: SmartShaped, injected, cooked, topside portion in SmartShape packaging

Image 17: SmartShaped, injected, cooked and sliced topside portion

4.3.4 Outside Flat Yield

The outside flat yield results are presented in Table 7. The outside flats were trimmed of external fat and connective tissue which resulted in an average yield loss of 21% for the three primals tested. The side muscle was removed and not SmartShaped due to its flat shape. This muscle accounted for an average of 17% of the primal weight. However it can be further processed as diced beef. The total average initial yield loss for the three outside flat primals was 38%.

The cooking yield loss was determined from the cooking liquid loss of the post trimming, post injecting and SmartShaping portions. In this instance the cooking yield loss was highest for the SmartShaped injected portions at 35%.

The finished product yields were calculated from the percent of usable sliced pieces from the initial primal taking into account the trimming loss and side muscle removal and including brine uptake. The SmartShaped injected portions gave the best overall yield of 53%.

4.4 Bonded Tenderloins

After discussions with Export Sales and site Operations it was decided the process for producing bonded tenderloins using SmartShape technology was not efficient and the expected value not sufficient to justify trials and capital investment.

4.5 Equipment Performance

The SmartShape machine was simple to operate and had a small footprint. The machine used in these trials was an early version and due to this the preparation phase of placing a bag on the bag holder was cumbersome. An automatic bag placement function would improve the process.

A further issue identified in these trials was the need to have relatively uniform meat portion sizes. A small portion did not SmartShape effectively and resulted in misshapen finished product. A portion that was slightly too large would not fit through the bag holder and had to

be removed and trimmed to fit. To overcome this issue portions could be graded prior to the process and different bag holders used. However this would affect the throughputs and therefore the efficiency of the process.

A disadvantage with this equipment was that it did not allow a continuous process. The machine is orientated such that gravity is a vital part of the function however if there was a way to make the process continuous or fully automated it would have better potential in a large scale commercial environment.

5 Cost Benefit Analysis

5.1 Consultants

Greenleaf Enterprises carried out a commercial evaluation and viability analysis of using the SmartShape system at Top Cut Foods Laverton, Melbourne. The analysis concentrated on the production of portion controlled and cooked rump steaks. Greenleaf have experience with the SmartShape system and used modelling previously developed to carry out the analyses. Data from trials and information gathered during a site visit to Top Cut Foods Laverton was used to complete the report.

The following considerations were included in their report;

- Yield implications
- Potential labour savings on plant
- Capital and installation costs, foot print required
- Economic impact
- Reliability
- Maintenance costs

The sections below summarise the key findings in each area.

5.2 CBA Summary Results

5.2.1 Benefits

The reduced yield losses resulted in a benefit of $*CIC* per kilogram and overall a benefit of *CIC* per annum given the volumes processed. The benefits were derived from the reduced yield loss, allowing more steaks to comply with customer specifications. The total net benefit was $*CIC*/kg or $*CIC* per annum based on the systems costs involved.

5.2.2 Costs

The costs associated with the implementation of the system, including capital, labour, consumables and repairs and maintenance, is $*CIC* /kg or $$*CIC* per annum. The biggest contributor to the $/kg cost is capital expenditure. As the processing volumes increase the capital expenditure will reduce on a per kg basis. The production volume is a sensitive parameter in the model. A further cost is an increase in labour costs due to further staff required to operate the SmartShape equipment.

5.2.3 Assumptions and ROI

The expected payback period using the yield information collected during the trials is 26.9 months with an NPV value of $*CIC*. This NPV calculation assumes a total production volume of 2.5MT per week over 52 weeks of production and a machine life of 10 years.

5.3 Process Flow Options

Greenleaf also proposed an alternative process flow to further reduce the yield losses. The suggestion is to cook the portioned primal in the SmartShaped bag and is based on the concept that steaks cooked in SmartShaped bags retain their shape better. The alternative process flow requires the company to have a high risk facility or to further pasteurise the product post cooking and slicing.

6 Conclusions/Recommendations

The results from these trials suggest the SmartShape technology delivers a consistently shaped portion and therefore a better portion controlled product. Primals with many muscle groups and different muscle directions are generally not suitable for SmartShaping and therefore the technology may be limited to a few select products.

The SmartShaped rump steaks resulted in better yields compared to control samples however low throughputs was identified as an issue for commercialisation.

The raw material costs for SmartShaped roast meats are higher than for the incumbent products. This means SmartShaped roast meats may not be suitable for cost driven customers in the Health and Aged Care sectors. SmartShaped portions offer customers better portion control and potentially a better quality product. There is therefore potential for whole muscle SmartShaped products to be used in ready meals and marketed as a premium product.

The cost benefit analysis determined the SmartShape technology delivers poor ROI if limited to the production of rump steaks using the current process. The addition of other products and work done on improving the process flow should see benefits in investing in the technology.

7 Bibliography

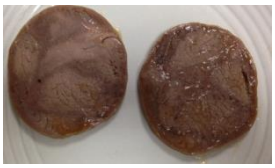
Bryan K., Swanepoel T., Green P., (2015) SmartShaper . *Milestone Report presented by Greenleaf Enterprises. MLA*

Egan N., (2013) Trends in Aged Care. *Australian Ageing Agenda website http://www.australianageingagenda.com.au/2013/09/12/food-trends-in-aged-care/*

McPhail N., Stark J., Warner R., (2011) Feasibility of using cold-set binding with SmartShape technology and development of a process. *CSIRO Final Report (published by MLA)*

8 Appendix

8.1 Table 1: Retail market analysis of ready plated meals

Producer	McCain	On The Menu	Emily's Kitchen	Coles Cuisine
Store	Coles and Woolworths	Coles and Woolworths	Woolworths only	Coles Only
Product Name	Roast Beef	Angus Roast Beef	New York Style Pepper Steak	Steak with Mushroom Sauce
Image of packaging				
Retail Price	$5 per pack	$6.49 per pack	$10.59 per pack	$8.50 per pack
Pack Weight	320g	320g	400g	350g
Price/kg	$16	$20	$26	$24
Fresh, Chilled or Frozen	Frozen	Frozen	Chilled	Chilled
% Protein portion	30% meat including marinade	28% meat including marinade	43% no marinade	33% including marinade
Image of Protein				
Protein dimensions	90mm diameter, 7mm thickness	70mm diameter, 10mm thickness	Steak (Natural)	Chunk (Natural)
Protein Weight	45g each slice (2 slices) - cooked	~36g each slice (2 slices) - cooked	160g	137g
Pre-cooked/par cooked/raw	Precooked	Precooked	Sous vide cooked	Pre-cooked
Organoleptic	Obvious pieces of meat, slightly rubbery, moist and tender	Meat was tough and dry	Meat was crumbly but tender 	Meat was very tough and dry
Beef Marinade Ingredients	Beef marinade (water, starch (potato, pea), soy protein, salt, mineral salt (450), natural flavours, sugar)	Beef marinade (Water, Mineral Salts (450, 451), Sugar)	No beef marinade	Water and Salt (10% inclusion)