# final report

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Prepared by: Dr Rod Polkinghorne
Polkinghornes Pty Ltd

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Meat and Livestock Australia Limited
Locked Bag 1961
NORTH SYDNEY NSW 2059

# Product Collection for Future MSA Eating Quality Research

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# Executive summary

MSA consumer sensory testing and the resulting ability to predict consumer satisfaction for individual beef meal portions has been a major driver of industry change. This change being to a consumer focus with measurable revenue improvement to all sectors through the delivery of superior value.

Accurate prediction however, can only be built on substantial data and as MSA has expanded to support branding of a greater number of cuts to new markets, requests have grown for MSA prediction of further muscles or cuts coupled with alternative cooking methods. This research project provides a major pillar from which to deliver expanded outcomes and improved prediction across the carcase in a new MSA model.

To avoid the risk of confounding new cut x cook results with cattle type or environmental effects it is important that any testing be spread across a sufficiently diverse range of cattle. Further benefit is gained by testing a large array of muscles and treatments “within animal” as any environmental or genetic effect is common to all samples removing prediction variation.

The project objective was to collect a large number of samples from each carcase over a number of diverse cattle types and sources. The utilisation of progeny from three Beef Information Nucleus (BIN) programs provided an ideal base for the research. Eighteen head, in turn subdivided into three subgroups of 6 head with differing criteria, were utilised from each of the Northern BIN (Brahman, Droughtmaster and Santa Gertrudis), the Hereford crossbred BIN (black baldy Hereford over Angus, Angus over black baldy) and an Angus BIN (Low and High growth and myostatin). The Hereford BIN were grass fed in Tasmania whereas the Northern BIN were 100 day grainfed in Queensland and the Angus BIN 168 days on feed in NSW. The project was designed to sample cuts across a diverse cattle range with known genomic information: it was not designed to compare breeds.

Cuts were collected from both sides of the 54 head, all MSA compliant, selected from much larger groups. The cuts were processed down to individual muscles from 55 to 64 muscles collected from each carcase resulting in sampling of 67 different muscles, 26 of which had no prior MSA testing. Many of these were selected to enable MSA grading of the majority of product codes listed in the Handbook of Australian Meat. Fabrication of the muscles produced 7,261 consumer samples each to be evaluated by 10 consumers.

Further data value was delivered by the use of 8 alternative cooking methods, including sous-vide and osso bucco, to compare to the existing slow cook protocol, moist heat roasting relative to the standard dry roasting protocol and comparison of chuck and short rib cuts cooked on the bone to the component muscles from the other carcase side cooked boneless. In addition, the new samples provided current data for cuts that had either very low existing data or which had not been tested for many years. An ageing comparison was made to strengthen or establish estimates for cuts and to evaluate potential cooking interaction with ageing.

The consumer test results combined with the extensive data available through BIN records, MSA grading inputs and fabrication of the extensive muscle range and cooking methods have been a major source of data addition to the AUSBlue database and provided critical input to the development of a new generation of MSA prediction model.

This is expected to deliver increased value to the Australian beef industry through superior consumer prediction and an increased range of alternative muscle and cook alternatives that can be adopted to meet specific branding and market requirements.

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# 1 Background

The increased adoption of MSA grading across all Australian beef industry segments has assisted in building industry returns through a focus on consumer evaluation, providing improved value indication. As demand for MSA based brands has expanded, together with higher pricing, there has been increased interest in marketing further cuts as MSA graded together with evaluation of alternative cooking methods that are either relevant to specific markets or which could lead to improved eating quality for various cuts.

A partial driver to this has been the desire to apply an MSA standard to the full range of muscle codes in the Handbook of Australian Meat (HAM) (Anon.2005). In many cases the HAM definitions cover cut codes that encompass more than one muscle. Under MSA practice the multiple muscles can be graded and marketed with the grade assigned to the lowest MQ4 score muscle within the cut. At project inception there were a substantial number of muscles which had not been MSA evaluated and which were consequently ineligible for grading. This created difficulties where processors were promoting their MSA based brands but couldn't utilise the brands on some items sold in domestic and export markets.

Further cuts were previously evaluated only under a single cooking method which predicted a sensory outcome believed to be worse than that possible with alternative cooking techniques. There were also legitimate and important questions relating to a number of bone-in cuts and the potential difference to evaluation when cooked "off the bone".

In addition, a number of cooking methods; including Slow Cook and Stir Fry, had not been utilised in MSA testing for greater than 10 years. This lead to questions as to their currency with consumers and further, numbers tested within some cooking methods and muscle combinations were low, restricted to particular cattle types and/or had little to no ageing data from which to build prediction.

MSA is delivered by applying a predicted cook outcome for a nominated cut x cook combination which will further vary according to the source animal characteristics and treatments. Typical variations relate to animal type, Hormonal Growth Promotant (HGP) use, production background and/or age. The prediction models require extensive data gathered under controlled conditions to be robust. This robustness is increased when a wide range of muscles and muscle x cook combinations are drawn from a single carcase, or common group of carcases, as the "within animal" control reduces the potential confounding between animal or environmental impacts.

The acceleration of genomic application also makes cattle, with known genetic makeup and raised within common environments, highly desirable as a research resource. The project was designed to collect an extensive range of cuts from three Beef Improvement Nucleus (BIN) projects to provide three distinct cattle populations, representing breed differences. Multiple cooking styles, boneless and bone-in cooking and a range of cut ageing was planned to derive maximum value from the project through consumer testing of an extreme range of cattle with extensive animal background data.

A clear understanding of within animal cut differences across various contrasting cattle populations provided a strong base from which to examine relationships and incorporate in new prediction models.

# 2 Project objectives

The project objectives were listed as "facilitate the collection, cut up and picking and posting of product" from 3 separate kills.

Results will aim to:

- Improve model accuracy on cuts with limited information
- Expand the MSA model with new cut x cook combinations within the existing cook methods
- Create new cut x cook methods with novel cook methods
- Test existing cook methods, which may not have been tested recently, to see whether consumer sensory preferences have changed

# 3 Methodology

## 3.1 Collection Planning

The total project plan encompassed three separate BIN sources: Northern, Hereford (Black Baldy) and Angus BIN groups. To maximise the sample interconnection across the project and remain within budget it was decided to restrict each BIN group to 18 animals, with essentially all cuts collected from both sides of each to in turn provide the maximum possible comparison of cook type and ageing within muscle with sufficient replication across the total 54 head.

To further control range within the groups, 6 head were to be selected from each of 3 subsets within each of the BIN groups.

Within the Northern BIN 6 x Brahman, 6 x Santa Gertrudis and 6 x Droughtmaster carcases were to be selected based on their northern short fed production system. The Hereford BIN was located in Tasmania and designed to assess common Hereford commercial crosses with Hereford sires over Angus cows, first cross Hereford x Angus cows and pure Angus progeny sub populations from a southern grass fed production system. Six head were to be selected from each. The Angus BIN included high and low feedlot growth plus myostatin gene subsets, again with 6 head to be selected from each.

Original planning was based on a reference table, utilised in previous MSA research, to assign MSA muscle codes to muscles within cuts. The table, originally assembled by Alan Gee of Cosign Pty Ltd, combined the HAM Alphabetical List of Muscle Names with yield data published by Butterfield and May (1966) and other sources.

Portions of many muscles are present across multiple cuts. The MSA convention is to utilise a 6 digit alphanumeric code to relate the source cut in industry terminology (the first 3 letters) with the component muscles (the following 3 digits reflecting the HAM muscle number). As an example CHK045, CUB045 and STR045 together with STA045 and STP045 all denote the *M.longissimus dorsi* within the chuck, cube roll, striploin or anterior and posterior striploin respectively. This enables a test of muscle position effects in addition to muscle relationships to eating quality.

*Table 1* presents the original source table with additions and includes muscles currently not sensory tested. A calculated weight for a 300Kg carcase is shown and was observed in initial selection of possible new muscles worthy of testing due to their mass and potential to be individually harvested if found to have sensory merit.

MSA consumer sensory protocols require 10 consumers per sample, which dictates a minimum sample size, varying somewhat with cooking method. For smaller muscles it was planned to make a single sample after combining a muscle from both carcase sides.

***Table 1. HAM muscles & numbers, MSA codes and estimated weight for a 300Kg carcase.***

| HAM No | H.A.M. Muscle Name | Body % | HAM | HAM | %inPr | F/H | Wgt@30( | MSA Code |
|---|---|---|---|---|---|---|---|---|
| 1 | M.adductor femoris | 1.90% | Topside/cap off | 2000, 2001 | 100% | Hind | 1.767 | TOP001 |
| 2 | M.anconaeus | 0.10% | Blade | 2300 | 80% | Fore | 0.074 | |
| 3 | M.articularis genu | 0.08% | Thick Flank | 2060 | 100% | Hind | 0.074 | |
| 4 | M.biceps brachii | 0.67% | Fore Shin | 2360, 2365 | 100% | Fore | 0.623 | FQS004 |
| 5 | M.biceps femoris (syn. gluteobiceps | 7.29% | Full Rump, Rump Cap | 2080, 2091 | 19% | Hind | 1.288 | RMP005 |
| 5 | M.biceps femoris (syn. gluteobiceps | 7.29% | Silverside, Outside | 2020, 2030 | 81% | Hind | 5.492 | OUT005 |
| 6 | M.brachialis | 0.48% | Blade | 2300 | 20% | Fore | 0.089 | |
| 6 | M.brachialis | 0.48% | Chuck | 2260 | 20% | Fore | 0.089 | |
| 6 | M.brachialis | 0.48% | Fore Shin | 2360, 2365 | 60% | Fore | 0.268 | FQS006 |
| 7 | M.brachiocephalicus | 1.46% | Chuck | 2260 | 100% | Fore | 1.358 | CHK007 |
| 8 | M.coracobrachialis | 0.15% | Blade | 2300 | 100% | Fore | 0.140 | |
| 9 | M.cutaneus omobrachialis | | | | | | 0.000 | |
| 10 | M.cutaneus trunci | 1.63% | Brisket | 2320 | 24% | Fore | 0.364 | |
| 10 | M.cutaneus trunci | 1.63% | Chuck | 2260 | 7% | Fore | 0.106 | |
| 10 | M.cutaneus trunci | 1.63% | Rib Set | 2223 | 9% | Fore | 0.136 | |
| 10 | M.cutaneus trunci | 1.63% | Thick Flank | 2060 | 5% | Hind | 0.076 | |
| 10 | M.cutaneus trunci | 1.63% | Thin Flank | 2200 | 55% | Fore | 0.834 | |
| 11 | M.deltoideus | 0.50% | Blade | 2300 | 100% | Fore | 0.465 | BLD011 |
| 12 | M.diaphragma | 0.10% | Brisket | 2320 | 61% | Fore | 0.057 | |
| 12 | M.diaphragma | 0.10% | Chuck | 2260 | 31% | Fore | 0.029 | |
| 13 | M.extensor carpi obliquus | 0.02% | Fore Shin | 2360 | 100% | Fore | 0.019 | |
| 14 | M.extensor carpi radialis | 0.73% | Blade | 2300 | 33% | Fore | 0.224 | |
| 14 | M.extensor carpi radialis | 0.73% | Fore Shin | 2360 | 67% | Fore | 0.455 | FQShin |
| 15 | M.extensor carpi ulnaris | 0.29% | Fore Shin | 2360 | 100% | Fore | 0.270 | |
| 16 | M.extensor digiti quarti proprius | 0.21% | Fore Shin | 2360 | 100% | Fore | 0.195 | |
| 17 | M.extensor digiti quarti proprius (pe | 0.25% | Hind Shank | 2360 | 100% | Hind | 0.233 | OUT017 |
| 18 | M.extensor digiti tertii proprius | 0.12% | Fore Shin | 2360 | 100% | Fore | 0.112 | |
| 19 | M.extensor digiti tertii proprius (ped | 0.25% | Hind Shank | 2360 | 100% | Hind | 0.233 | |
| 20 | Mextensor digitorum communis | 0.08% | Fore Shin | 2360 | 100% | Fore | 0.074 | |
| 21 | M.extensor digitorum longus | 0.25% | Hind Shank | 2360 | 100% | Hind | 0.233 | |
| 22 | M.flexor carpi radialis | 0.11% | Fore Shin | 2360 | 100% | Fore | 0.102 | |
| 23 | M.flexor carpi ulnaris | 0.15% | Fore Shin | 2360 | 100% | Fore | 0.140 | |
| 24 | M.flexor digitorum longus | 0.20% | Hind Shank | 2360 | 100% | Hind | 0.186 | |
| 25 | M.flexor digitorum profundus | 0.64% | Fore Shin | 2360 | 100% | Fore | 0.595 | FQShin |
| 26 | M.flexor digitorum profundus (pedis) | | | | | | 0.000 | |
| 27 | M.flexor digitorum sublimis | 0.36% | Fore Shin | 2360 | 100% | Fore | 0.335 | |
| 27a | M.flexor digitorum sublimis (pedis) | 0.44% | Silverside | 2020 | 100% | Hind | 0.409 | |
| 28 | M.flexor hallucis longus | 0.63% | Hind Shank | 2360 | 100% | Hind | 0.586 | HQShin |
| 29 | M.gastrocnemius | 2.07% | Silverside, Outside | 2020, 2030 | 100% | Hind | 1.925 | OUT029 |
| 30 | M.gluteus accessorius | 0.28% | Full Rump | 2080 | 100% | Hind | 0.260 | RMP030 |
| 31 | M.gluteus medius | 3.82% | Full Rump | 2080 | 94% | Hind | 3.339 | RMP031 |
| 31 | M.gluteus medius | | Rostbiff | 2110 | | | | RMP131 (2/3 portion) |
| 31 | M.gluteus medius | | Rostbiff | 2110 | | | | RMP231 (1/3 portion) |
| 31 | M.gluteus medius | 3.82% | Striploin | 2140 | 6% | Hind | 0.213 | |
| 32 | M.gluteus profundus | 1.25% | Full Rump | 2080 | 100% | Hind | 1.163 | RMP032 |
| 33 | M.gracilis | 1.40% | Topside, Topside Cap | 2000, 2002 | 100% | Hind | 1.302 | TOP033 |

| HAM No | H.A.M. Muscle Name | Body % | HAM | HAM | %inPr | F/H | Wgt@30( | MSA Code |
|---|---|---|---|---|---|---|---|---|
| 34 | M.iliacus | 0.88% | Tenderloin, Butt Tenderloin | 2150, 2170 | 100% | Hind | 0.818 | TDR034 |
| 35 | M.iliocostalis | 0.46% | Rib Set | 2223 | 63% | Fore | 0.270 | |
| 35 | M.iliocostalis | 0.46% | Rib Set | 2223 | 19% | Fore | 0.081 | |
| 35 | M.iliocostalis | 0.46% | Striploin | 2140 | 18% | Hind | 0.077 | |
| 36 | M.infraspinatus | 2.02% | Blade, Oyster Blade | 2300, 2303 | 90% | Fore | 1.691 | OYS036 |
| 36 | M.infraspinatus | 2.02% | Rib Set | 2223 | 10% | Fore | 0.188 | |
| 37 | M.intercostales externus and intern | 2.59% | Brisket | 2320 | 22% | Fore | 0.530 | |
| 37 | M.intercostales externus and intern | 2.59% | Chuck | 2260 | 14% | Fore | 0.337 | CHK037 |
| 37 | M.intercostales externus and intern | 2.59% | Rib Set | 2223 | 42% | Fore | 1.012 | RIB037 |
| 37 | M.intercostales externus and internus | | Intercostals | 2430 | | | | INT037 |
| 37 | M.intercostales externus and intern | 2.59% | Striploin | 2140 | 5% | Hind | 0.120 | |
| 37 | M.intercostales externus and intern | 2.59% | Thin Flank | 2200 | 17% | Fore | 0.409 | |
| 38 | M.intertransversarii cervicis | 0.46% | Chuck | 2260 | 100% | Fore | 0.428 | |
| 39 | M.intertransversarius longus | 0.28% | Chuck | 2260 | 100% | Fore | 0.260 | |
| 40 | M.ischiocavernosus | 0.10% | Topside | 2000 | 100% | Hind | 0.093 | |
| 41 | M.latissimus dorsi | 2.04% | Blade | 2300 | 18% | Fore | 0.341 | BLD041 |
| 41 | M.latissimus dorsi | | Chuck | | | | | CHK041 |
| 41 | M.latissimus dorsi | 2.04% | Rib Set | 2223 | 80% | Fore | 1.518 | RIB041 |
| 42 | M.levatores costarum | | Rib Set | 2223 | 100% | Fore | 0.000 | |
| 43 | M.longissimus cervicis | 0.32% | Chuck | 2260 | 100% | Fore | 0.298 | |
| 44 | M.longissimus capitis et atlantis | 0.28% | Chuck | 2260 | 100% | Fore | 0.260 | |
| 45 | M.longissimus dorsi | 6.55% | Chuck | 2260, 2275 | 2% | Fore | 0.122 | CHK045 |
| 45 | M.longissimus dorsi | 6.55% | Cube Roll | 2244 | 28% | Fore | 1.706 | CUB045 |
| 45 | Mlongissimus dorsi | 6.55% | Striploin | 2140 | 70% | Hind | 4.264 | STR045 |
| 46 | M.longus capitis | 0.23% | Chuck | 2260 | 100% | Fore | 0.214 | |
| 47 | M.longus colli | 0.82% | Chuck | 2260 | 100% | Fore | 0.763 | CHK047 |
| 48 | M.multifidi cervicis | 0.25% | Chuck | 2260 | 100% | Fore | 0.233 | CHK048 |
| 49 | M.multifidi dorsi | 0.86% | Chuck | 2260 | 18% | Fore | 0.144 | |
| 49 | M.multifidi dorsi | 0.86% | Rib Set | 2223 | 18% | Fore | 0.144 | |
| 49 | M.multifidi dorsi | 0.86% | Striploin | 2140 | 64% | Hind | 0.512 | STR049 |
| 50 | M.obliquus capitus caudalis | 0.34% | Chuck | 2260 | 100% | Fore | 0.316 | |
| 51 | M.obliquus externus abdominis | 2.17% | Brisket | 2320 | 37% | Fore | 0.747 | |
| 51 | M.obliquus externus abdominis | 2.17% | Thin Flank | 2200 | 63% | Hind | 1.271 | TFL051 |
| 52 | M.obliquus internus abdominis | 1.63% | Full Rump | 2080 | 20% | Hind | 0.303 | |
| 52 | M.obliquus internus abdominis | 1.63% | Thin Flank, Flap Meat | 2200, 2206 | 80% | Hind | 1.213 | TFL052 |
| 53 | M.obturator externus and internus | 0.58% | Topside | 2000 | 100% | Hind | 0.539 | |
| 54 | M.omotransversarius | 0.53% | Chuck | 2260 | 100% | Fore | 0.493 | |
| 55 | M.pectineus | 0.63% | Topside | 2000 | 100% | Hind | 0.586 | TOP055 |
| 56 | M.pectoralis profundus | 3.72% | Brisket, Pectoral | 2320, 2328 | 77% | Fore | 2.664 | BRI056 |
| 56 | M.pectoralis profundus | 3.72% | Chuck | 2260 | 23% | Fore | 0.796 | CHK056 |
| 57 | M.pectoralis superficialis | 1.50% | Brisket, Profundis | 2320, 2332 | 95% | Fore | 1.325 | BRI057 |
| 57 | M.pectoralis superficialis | 1.50% | Chuck | 2260 | 5% | Fore | 0.070 | |
| 58 | M.peronaeus longus | 0.10% | Hind Shank | 2360 | 100% | Hind | 0.093 | |
| 59 | M.peronaeus tertius | 0.25% | Hind Shank | 2360 | 100% | Hind | 0.233 | HQS059 |
| 60 | M.popliteus | 0.29% | Hind Shank | 2360 | 100% | Hind | 0.270 | |
| 61 | M.protractor praeputii | 0.05% | Brisket | 2320 | 100% | Fore | 0.047 | |
| 62 | M.psoas major | 1.70% | Tenderloin | 2150 | 100% | Hind | 1.581 | TDR062 |
| 63 | M.psoas minor | 0.34% | Tenderloin | 2150 | 100% | Hind | 0.316 | |
| 64 | M.rectus abdominis | 2.13% | Brisket | 2320 | 48% | Fore | 0.951 | |
| 64 | M.rectus abdominis | 2.13% | Thin Flank | 2200 | 52% | Fore | 1.030 | TFL064 |
| 65 | M.rectus capitis dorsalis major | 0.05% | Chuck | 2260 | 100% | Fore | 0.047 | |
| 66 | M.rectus femoris | 2.12% | Thick Flank | 2060, 2067 | 100% | Hind | 1.972 | KNU066 |
| 67 | M.rectus thoracis | 0.14% | Brisket | 2320 | 100% | Fore | 0.130 | |
| 68 | M.rhomboideus | 1.45% | Chuck, Chuck Crest | 2260, 2278 | 70% | Fore | 0.944 | CHK068 |
| 68 | M.rhomboideus | 1.45% | Rib Set | 2223 | 30% | Fore | 0.405 | |
| 69 | M.sacrococcygeus dorsalis et latera | 0.14% | Full Rump | 2080 | 50% | Hind | 0.065 | |
| 69 | M.sacrococcygeus dorsalis et latera | 0.14% | Scrap | 2080 | 50% | Hind | 0.065 | |
| 70 | M.sartorius | 0.39% | Thick Flank | 2060 | 50% | Hind | 0.181 | |
| 70 | M.sartorius | 0.39% | Topside | 2000 | 50% | Hind | 0.181 | |

| HAM No | H.A.M. Muscle Name | Body % | HAM | HAM | %inPr | F/H | Wgt@30( | MSA Code |
|---|---|---|---|---|---|---|---|---|
| 71 | M.scalenus dorsalis | 0.17% | Chuck | 2260 | 100% | Fore | 0.158 | |
| 72 | M.scalenus ventralis | 0.58% | Chuck | 2260 | 100% | Fore | 0.539 | |
| 73 | M.semimembranosus | 5.24% | Topside, Cap Off | 2000, 2001 | 100% | Hind | 4.873 | TOP073 |
| 74 | M.semispinalis capitis | 1.55% | Chuck, Chuck Eye Roll | 2260, 2275 | 88% | Fore | 1.269 | CHK074 |
| 74 | M.semispinalis capitis | 1.55% | Rib Set | 2223 | 12% | Fore | 0.173 | |
| 75 | M.semitendinosus | 2.59% | Silverside, Eye Round | 2020, 2040 | 100% | Hind | 2.409 | EYE075 |
| 76 | M.serratus dorsalis caudalis | 0.12% | Rib Set | 2223 | 95% | Fore | 0.106 | |
| 76 | M.serratus dorsalis caudalis | 0.12% | Striploin | 2140 | 5% | Fore | 0.006 | |
| 77 | M.serratus dorsalis cranialis | 0.13% | Chuck | 2260 | 5% | Fore | 0.006 | |
| 77 | M.serratus dorsalis cranialis | 0.13% | Rib Set | 2223 | 95% | Fore | 0.115 | |
| 78 | M.serratus ventralis cervicis | 3.12% | Chuck | 2260 | 100% | Fore | 2.902 | CHK078 |
| 79 | M.serratus ventralis thoracis | 1.34% | Brisket | 2320 | 29% | Fore | 0.361 | |
| 79 | M.serratus ventralis thoracis | 1.34% | Chuck | 2260 | 23% | Fore | 0.287 | |
| 79 | M.serratus ventralis thoracis | 1.34% | Rib Set | 2223 | 48% | Fore | 0.598 | RIB078 |
| 80 | M.soleus | 0.10% | Silverside | 2020 | 100% | Hind | 0.093 | |
| 81 | M.spinalis dorsi | 1.64% | Chuck, Chuck Eye Roll | 2260, 2275 | 31% | Fore | 0.473 | CHK081 |
| 81 | M.spinalis dorsi | 1.64% | Rib Set, Cube Roll | 2223, 2244 | 60% | Fore | 0.915 | CUB081 |
| 81 | M.spinalis dorsi | 1.64% | Striploin | 2140 | 9% | Hind | 0.137 | |
| 82 | M.splenius | 0.77% | Chuck | 2260 | 100% | Fore | 0.716 | |
| 83 | M.sternocephalicus | 0.05% | Brisket | 2320 | 15% | Fore | 0.007 | |
| 83 | M.sternocephalicus | 0.05% | Chuck | 2260 | 85% | Fore | 0.040 | |
| 84 | M.subscapularis | 1.17% | Blade | 2300, 2304 | 95% | Fore | 1.034 | BLD084 |
| 84 | M.subscapularis | 1.17% | Rib Set | 2223 | 5% | Fore | 0.054 | |
| 85 | M.supraspinatus | 1.52% | Chuck Tender | 2310 | 100% | Fore | 1.414 | CTR085 |
| 86 | M.tensor fasciae antibrachii | 0.16% | Blade | 2300 | 100% | Fore | 0.149 | |
| 87 | M.tensor fasciae latae | 1.36% | Full Rump, Tri-Tip | 2080, 2131 | 72% | Hind | 0.911 | RMP087 |
| 87 | M.tensor fasciae latae | 1.36% | Thick Flank | 2060 | 28% | Hind | 0.354 | |
| 88 | M.teres major | 0.46% | Blade | 2300 | 100% | Fore | 0.428 | BLD088 |
| 89 | M.teres minor | 0.20% | Blade | 2300 | 100% | Fore | 0.186 | |
| 90 | M.tibialis anterior | 0.12% | Hind Shank | 2360 | 100% | Hind | 0.112 | |
| 91 | M.tibialis posterior | 0.12% | Hind Shank | 2360 | 100% | Hind | 0.112 | |
| 92 | M.transversus abdominis | 1.21% | Brisket | 2320 | 45% | Fore | 0.506 | |
| 92 | M.transversus abdominis | 1.21% | Thin Flank | 2200 | 55% | Hind | 0.619 | |
| 93 | M.trapezius cervicalis | 0.54% | Chuck | 2260 | 100% | Fore | 0.502 | |
| 94 | M.trapezius thoracis | 0.52% | Chuck | 2260 | 15% | Fore | 0.073 | |
| 94 | M.trapezius thoracis | 0.52% | Rib Set | 2223 | 85% | Fore | 0.411 | |
| 95 | M.triceps brachii caput laterale | 0.65% | Blade | 2300 | 100% | Fore | 0.605 | BLD095 |
| 96 | .Mtriceps brachii caput longum | 3.13% | Blade | 2300 | 100% | Fore | 2.911 | BLD096 |
| 97 | M.triceps brachii caput mediale | 0.10% | Blade | 2300 | 100% | Fore | 0.093 | BLD097 |
| 98 | M.vastus intermedius | 0.70% | Thick Flank | 2060 | 100% | Hind | 0.651 | KNU098 |
| 99 | M.vastus lateralis | 2.59% | Thick Flank | 2060 | 100% | Hind | 2.409 | KNU099 |
| 100 | M.vastus medialis | 0.70% | Thick Flank | 2060 | 100% | Hind | 0.651 | KNU100 |

Prior MSA testing, and the associated cooking, had been conducted after removal of all bone to provide a consistent muscle preparation and presentation protocol. However, questions had arisen regarding cooking “on the bone” and possible flavour benefits. To provide a test of this possibility it was planned to cook some rib and shin cuts, in both bone-in and boneless form, with the bone removed after cooking and prior to serving, to provide a consumer comparison. For the shin cuts the alterative cooks were coded as SC2 (Slow Cooked for 2 hours – the standard protocol) and OSO (Osso Bucco). As the lower shin portion contains many small muscles, these were not separated in either form.

For the rib and chuck cuts however, the bone-in alternatives required multiple muscles (intercostals and covering profundus, serratus or latissimus) to be cooked as a single piece which might or might not be impacted by the presence of bone or, alternatively, by being cooked as a common mass. To provide data and assess these possibilities, the bone-in comparison designated cooking the cut and included muscles from one carcase side bone-in with those from the paired side to be cooked with the same muscles without bone, but bound together with netting. Muscle codes were created by adding a first 1 integer for those cooked bone-in and a 2 integer for those cooked as a group without bone. *Table 2* provides an overview of the coding used.

***Table 2. Codes used to identify common muscles cooked as bone-in or boneless cuts.***

| HAM description and Code | No | CODE | Muscle | Preparation Notes |
|---|---|---|---|---|
| Spare ribs 1695 | *37* | *CHK137* | *M.intercostales externus and internus* | When prepared bone in as spare ribs (intercostales only muscle included) |
| Chuck short ribs 1631 | *56* | *CHK156* | *M.pectoralis profundus* | When prepared as chuck rib (ribs 1 to 2/3) with rib bones, profundus & intercostales included. |
| Chuck short ribs 1631/Chuck rib meat 1696 | *78* | *CHK178* | *M.serratus ventralis cervicis* | When prepared as chuck rib (ribs 3 to 5)with rib bones, serratus & intercostales included |
| | *37* | *INT237* | *M.intercostales externus and internus* | When cooked boneless with intercostales (position unknown) & covering muscles separated after cooking |
| Chuck rib meat 2640/chuck meat square 2645 | *56* | *CHK256* | *M.pectoralis profundus* | Matched boneless equivalent to 156 chuck rib (ribs 1 to 2/3), profundus & intercostales included. |
| Chuck rib meat 2640/chuck meat square 2645 | *78* | *CHK278* | *M.serratus ventralis cervicis* | Matched boneless equivalent to 178 chuck rib (ribs 3 to 5), serratus & intercostales included. |
| | *37* | *CHK337* | *M.intercostales externus and internus* | Intercostales separated after cooking on bone with covering muscles as Chuck Ribs |
| | | | | |
| Spare ribs 1695 | *37* | *RIB137* | *M.intercostales externus and internus* | When prepared bone in as spare ribs (intercostales only muscle included) |
| Short ribs 1694 | *41* | *RIB141* | *M.latissimus dorsi* | When prepared as short ribs with rib bones, latissimus & intercostales muscles included |
| | *37* | *INT237* | *M.intercostales externus and internus* | When cooked boneless with intercostales (position unknown) & covering muscles separated after cooking |
| Rib meat square 2650 | *41* | *RIB241* | *M.latissimus dorsi* | Matched boneless equivalent to 141 short rib with latissimus & intercostales included. |
| | *37* | *RIB337* | *M.intercostales externus and internus* | Intercostales separated after cooking on bone with covering muscles as Short Ribs |

Further cooking alternatives were also planned to evaluate moist roasting in a Combi oven (COM) relative to the dry roasting (RST) protocol and to compare a sous-vide (SVD) slow cooking method to the standard SC2. It was also agreed that stirfry (SFR) and yakinku (YAK) should be contrasted with the SC2 and SVD prepared within muscle, where size permitted. This was also included to update consumer response to SC2, YAK and SFR cooking methods.

A final agreed design overlay was to contrast ageing within, in particular, the slow cooking methods (SC2 and SVD). This arose from recent data analysis indicating that ageing effects were significantly reduced for SC2 samples. If upheld by more data this had implications for prediction modelling as ageing estimates may need to interact with cook type in addition to muscle, a fundamental revision to the SP2009 and earlier models which applied common ageing to a muscle across all cook types.

Mr Greg Butler and Mr Steve Humphries, both highly experienced butchers and trainers in research and industry muscle identification and boning practice, were engaged in the cut up and sample preparation to assist in muscle identification. Both have been key contributors to developing MSA sample preparation protocols over many years. Janine Lau, Jessira Perovic and Rod Polkinghorne also assisted in defining consumer sample preparation standards. The final collection and MSA sample preparation within each kill was marginally modified to account for muscle size, and in light of experience with previous groups.

### 3.1.1 Grading and Cut collection

The Northern BIN group were harvested at a Southern Queensland plant on February 27$^{th}$, 2017, the Hereford BIN at a Tasmanian plant on March 14$^{th}$, 2017 and the Angus BIN at the same Southern Queensland plant on April 5$^{th}$, 2017.

All cattle were steers and none were HGP treated. Each of the BIN groups had been fattened together providing uniform environmental conditions within each BIN but different across the three locations which were in Queensland (Northern and grain fed 100 days), NSW (Angus and grainfed for 168 days) and Tasmania (Hereford and grass fed). All carcases were AT hung. ***It should be emphasised that the purpose of the research was not to compare breeds*** but rather to ensure that the consumer samples, prepared from an extensive muscle range, were representative of a diverse cattle population to reduce the risk of confounding muscle and cook results with breed or environmental effects.

On each occasion the 18 head, and the subsets of 6 within the 18, were selected from much larger numbers after MSA grading and reference to pH and temperature decline data to ensure all carcases utilised complied with MSA criteria.

*Tables 3* to *5* display the principal grading inputs for each of the BIN groups and sub groups.

***Table 3. Grading inputs for Northern BIN carcases selected for sensory sampling***

| SUBGROUP | | HSCW | Epbi | Hump | Ema | Ossification | Ausmeat Marbling | Msa Marbling | RibFat | Ph | MSAIndex |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Brahman** | Min | 334 | 100 | 140 | 76 | 130 | 0 | 150 | 4 | 5.41 | 52.24 |
| 100% TBC | **Average** | **345** | 100 | **174** | **85** | **147** | **1** | **283** | **8** | **5.51** | **53.80** |
| | Max | 358 | 100 | 210 | 91 | 170 | 1 | 330 | 9 | 5.58 | 55.04 |
| | StdDev | 10.15 | 100 | 28.53 | 5.19 | 15.06 | 0.52 | 68.61 | 2.07 | 0.07 | 1.24 |
| | | | | | | | | | | | |
| **Droughtmaster** | Min | 342 | 50 | 85 | 75 | 130 | 0 | 190 | 5 | 5.45 | 56.10 |
| 50% TBC | **Average** | **347** | 50 | **104** | **85** | **138** | **1** | **265** | **9** | **5.50** | **57.15** |
| | Max | 353 | 50 | 125 | 100 | 150 | 1 | 340 | 13 | 5.54 | 57.95 |
| | StdDev | 5.17 | 50 | 17.72 | 9.41 | 7.53 | 0.55 | 68.63 | 2.83 | 0.04 | 0.79 |
| | | | | | | | | | | | |
| **Santa Gertrudis** | Min | 367 | 37.5 | 85 | 88 | 120 | 0 | 200 | 5 | 5.47 | 57.59 |
| 37.5% TBC | **Average** | **375** | 37.5 | **105** | **93** | **142** | **0** | **277** | **9** | **5.53** | **58.34** |
| | Max | 384 | 37.5 | 120 | 104 | 190 | 1 | 350 | 13 | 5.60 | 59.50 |
| | StdDev | 7.20 | 37.5 | 13.04 | 5.79 | 24.83 | 0.52 | 54.28 | 2.58 | 0.06 | 0.76 |
| | | | | | | | | | | | |
| **ALL Northern** | Min | 334 | 37.5 | 85 | 75 | 120 | 0 | 150 | 4 | 5.41 | 52.24 |
| | **Average** | **356** | | **128** | **88** | **142** | **1** | **275** | **8** | **5.51** | **56.27** |
| | Max | 384 | 100 | 210 | 104 | 190 | 1 | 350 | 13 | 5.60 | 59.50 |
| | StdDev | 16.04 | | 39.00 | 7.71 | 16.65 | 0.51 | 60.80 | 2.45 | 0.06 | 2.23 |
| | | | | | | | | | | | |
| ** All groups Male, 100 Days on Feed, No HGP and AT hung | | | | | | | | | | | |

***Table 4. Grading inputs for Hereford BIN carcases selected for sensory sampling***

| SUBGROUP | | Dentition | HSCW | P8 Fat | Hump | Ema | Ossification | Ausmeat Marbling | Msa Marbling | RibFat | Ph | MSAIndex |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Hereford x Angus** | Min | 0 | 292 | 5 | 65 | 74 | 120 | 0 | 230 | 3 | 5.47 | 58.21 |
| | **Average** | **1** | **306** | **5** | **68** | **83** | **135** | **0** | **293** | **5** | **5.60** | **59.76** |
| | Max | 4 | 321 | 7 | 70 | 97 | 150 | 1 | 340 | 7 | 5.70 | 60.78 |
| | StdDev | 1.67 | 12.06 | 0.82 | 2.58 | 8.07 | 12.25 | 0.52 | 43.67 | 1.47 | 0.10 | 0.94 |
| | | | | | | | | | | | | |
| **Angus x (Hereford x Angus)** | Min | 0 | 286 | 5 | 60 | 72 | 120 | 0 | 260 | 3 | 5.43 | 58.97 |
| | **Average** | **0** | **301** | **8** | **70** | **77** | **135** | **1** | **313** | **6** | **5.50** | **59.96** |
| | Max | 0 | 310 | 10 | 85 | 83 | 140 | 3 | 530 | 8 | 5.57 | 63.17 |
| | StdDev | 0.00 | 8.81 | 1.75 | 10.49 | 4.85 | 8.37 | 1.22 | 106.33 | 1.72 | 0.05 | 1.61 |
| | | | | | | | | | | | | |
| **Angus** | Min | 0 | 290 | 4 | 55 | 70 | 130 | 1 | 300 | 3 | 5.44 | 58.94 |
| | **Average** | **0** | **298** | **7** | **72** | **77** | **133** | **1** | **323** | **5** | **5.52** | **59.99** |
| | Max | 0 | 312 | 9 | 80 | 81 | 140 | 1 | 350 | 7 | 5.63 | 60.93 |
| | StdDev | 0.00 | 8.81 | 1.76 | 9.83 | 4.89 | 5.16 | 0.00 | 18.62 | 1.41 | 0.08 | 0.76 |
| | | | | | | | | | | | | |
| **ALL Hereford BIN** | Min | 0 | 286 | 4 | 55 | 70 | 120 | 0 | 230 | 3 | 5.43 | 58.21 |
| | **Average** | **0** | **302** | **7** | **70** | **79** | **134** | **1** | **310** | **5** | **5.54** | **59.90** |
| | Max | 4 | 321 | 10 | 85 | 97 | 150 | 3 | 530 | 8 | 5.70 | 63.17 |
| | StdDev | 1.03 | 10.01 | 1.72 | 8.04 | 6.45 | 8.56 | 0.78 | 64.44 | 1.52 | 0.09 | 1.10 |
| | | | | | | | | | | | | |
| *** Note all cattle Male, grass fed, HGP free and AT Hung | | | | | | | | | | | | |

The Angus BIN cattle were sourced from a long running research herd in which cattle had been continually selected for high and low muscling and for myostatin gene amplitude providing a well documented herd with extensive variation. The subgroups selected were based on the highest and lowest feedlot growth rates for two subgroups with myostatin the third.

***Table 5. Grading inputs for Angus BIN carcases selected for sensory sampling***

| SUBGROUP | | HSCW | Hump | Ema | Ossification | Ausmeat Marbling | Msa Marbling | RibFat | Ph | MSAIndex |
|---|---|---|---|---|---|---|---|---|---|---|
| **High Growth** | Min | 317 | 75 | 76 | 110 | 1 | 340 | 10 | 5.47 | 63.11 |
| | **Average** | **360** | **87** | **81** | **122** | **2** | **412** | **14** | **5.52** | **64.03** |
| | Max | 403 | 100 | 90 | 140 | 3 | 510 | 19 | 5.55 | 65.57 |
| | StdDev | 28.61 | 11.25 | 5.08 | 11.69 | 0.75 | 59.47 | 3.76 | 0.03 | 1.04 |
| | | | | | | | | | | |
| **Low Growth** | Min | 311 | 65 | 66 | 100 | 1 | 320 | 10 | 5.47 | 60.56 |
| | **Average** | **335** | **74** | **81** | **128** | **1** | **382** | **13** | **5.52** | **63.64** |
| | Max | 350 | 80 | 90 | 170 | 3 | 530 | 17 | 5.69 | 65.94 |
| | StdDev | 13.16 | 5.85 | 8.13 | 24.83 | 0.82 | 74.68 | 2.93 | 0.08 | 2.28 |
| | | | | | | | | | | |
| **Myostatin** | Min | 291 | 70 | 83 | 130 | 1 | 320 | 7 | 5.48 | 59.58 |
| | **Average** | **331** | **81** | **92** | **155** | **1** | **335** | **11** | **5.52** | **60.47** |
| | Max | 368 | 85 | 105 | 180 | 1 | 350 | 14 | 5.61 | 61.90 |
| | StdDev | 33.19 | 5.85 | 8.38 | 18.71 | 0.00 | 10.49 | 2.48 | 0.05 | 0.86 |
| | | | | | | | | | | |
| **ALL ANGUS BIN** | Min | 291 | 65 | 66 | 100 | 1 | 320 | 7 | 5.47 | 59.58 |
| | **Average** | **342** | **81** | **85** | **135** | **1** | **376** | **13** | **5.52** | **62.71** |
| | Max | 403 | 100 | 105 | 180 | 3 | 530 | 19 | 5.69 | 65.94 |
| | StdDev | 28.09 | 9.22 | 8.63 | 23.33 | 0.70 | 61.37 | 3.25 | 0.06 | 2.18 |
| | | | | | | | | | | |
| *** All Male, No HGP, 168 Days on Feed and AT Hung | | | | | | | | | | |

Subsequent management of the selected carcases, and cuts within each collection, was effected by CutUpDeveloper (CUD) files produced from standard MSA software as described by Polkinghorne and Gee (2006). In brief, the CUD software provided a means to develop a design designating the linkage from BIN group : to sub group : to body : to side : to primal : to muscle : to muscle position : to individual consumer sample. Each sample was further designated for cooking method and days of ageing post mortem. The software was also utilised to produce control files and identification labels for the sides, primal and final samples, which were assigned unique 4 digit alphanumeric EQSRef codes, used for sample identification through to serving of the 10 consumers to which each sample was assigned.

*Figure 1* displays a portion of the CUD input in which groups and subgroups are defined and the required muscles designated. Further processes designate muscle positions, cooking method(s) and ageing as partially depicted in *Figure 2*. From this point the software was used as an aid to develop a balanced design to ensure carcase side and muscle position was balanced across cook and ageing.

The software also produced an Acquisition Sheet for each kill that pre-assigned primal number identification to the primals to be collected with those for the left side of one body displayed in *Figure 3*.

***Figure 1. Portion of CUD design input allocating group, subgroup and muscle requirements***

Jump to Model | Jump to Display Cut Up | Jump to Input sht | Create and Install Body Sides | Expand Kill into Model for Cuts

| Master Group Number | KILL (Group) | Kill Date | Abattoir or Works | Groups Incorp. | Groups Solo |
|---|---|---|---|---|---|
| 492 | 492 | Thu 23 Feb 17 | Warwick | | 36 |
| | | | | Total Sides | Total Sides |

| GROUP DESC | GROUP | No. of SIDES | | L or R or LR or L/R | HANG | STIM | BLD084 | BLD088 | BLD095 | BLD096 | CTR085 | STR045 | OYS036 | CHK007 | CHK041 | CHK047 | CHK068 | CHK074 | CHK078 | CHK081 | CHK082 | RIB037 | RIB041 | RIB079 | RIB137 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BBBB | 492.1 | 12 | | LR | AT | LVES | y | y | y | y | y | y | y | y | y | y | y | y | y | y | y | y | y | y | y |
| DMDM | 492.2 | 12 | | LR | AT | LVES | y | y | y | y | y | y | y | y | y | y | y | y | y | y | y | y | y | y | y |
| SGSG | 492.3 | 12 | | LR | AT | LVES | y | y | y | y | y | y | y | y | y | y | y | y | y | y | y | y | y | y | y |
| Group Totals of BodySides | | 36 | | | | | | | | | | | | | | | | | | | | | | | |

***Figure 2. Portion of CUD design input designating muscle position, cook and days ageing***

Jump to Kill | Jump to Display Cut Up | Test Model as Cut Up | Publish Acquisition Sheet

| MSTR GROUP | GROUP | COMMENT | DEG FRD | CELL QTY | SIDES | CUT NAME | SUM POS | POS 1 | POS 2 | POS 3 | POS 4 | SUM COOKS | ROTATE COOKS | GRL | RST | SFR | YAK | SC2 | SOU | No. AGES | ROTATE AGES | AGE 1 | AGE 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 492 | 492.1 | BBBB | 12 | 12 | 12 | BLD084 | 1 | C | | | | 1 | | | | 1 | | | | 1 | | 10 | |
| 492 | 492.1 | BBBB | 12 | 12 | 12 | BLD088 | 1 | C | | | | 1 | | 1 | | | | | | 1 | | 10 | |
| 492 | 492.1 | BBBB | 12 | 12 | 12 | BLD095 | 1 | C | | | | 1 | | | | 1 | | | | 1 | | 10 | |
| 492 | 492.1 | BBBB | 36 | 12 | 12 | BLD096 | 3 | T | C1 | C2 | | 3 | | | 1 | 1 | 1 | | | 1 | | 10 | |
| 492 | 492.1 | BBBB | 24 | 12 | 12 | CTR085 | 2 | H | T | | | 2 | | 1 | 1 | | | | | 1 | | 10 | |
| 492 | 492.1 | BBBB | 48 | 12 | 12 | STR045 | 4 | A1 | A2 | P3 | P4 | 5 | | 1 | 2 | 1 | 1 | | | 1 | | 10 | |
| 492 | 492.1 | BBBB | 36 | 12 | 12 | OYS036 | 3 | H | C | T | | 3 | | | | 1 | | 1 | 1 | 1 | | 10 | |
| 492 | 492.1 | BBBB | 12 | 12 | 12 | CHK007 | 1 | C | | | | 1 | | | | | | 1 | | 1 | | 10 | |
| 492 | 492.1 | BBBB | 24 | 12 | 12 | CHK041 | 2 | C1 | C2 | | | 2 | | | 1 | | | 1 | | 1 | | 10 | |
| 492 | 492.1 | BBBB | 12 | 12 | 12 | CHK047 | 1 | C | | | | 1 | | | | | | 1 | | 1 | | 10 | |
| 492 | 492.1 | BBBB | 24 | 12 | 12 | CHK068 | 2 | C1 | C2 | | | 2 | | | | | | 1 | 1 | 2 | | 10 | 28 |
| 492 | 492.1 | BBBB | 12 | 12 | 12 | CHK074 | 1 | C | | | | 1 | | | 1 | | | | | 1 | | 10 | |
| 492 | 492.1 | BBBB | 36 | 12 | 12 | CHK078 | 3 | C1 | C2 | C3 | | 3 | | 1 | | | 1 | | 1 | 1 | | 10 | |
| 492 | 492.1 | BBBB | 12 | 12 | 12 | CHK081 | 1 | C | | | | 1 | | 1 | | | | | | 1 | | 10 | |
| 492 | 492.1 | BBBB | 12 | 12 | 12 | CHK082 | 1 | C | | | | 1 | | | | 1 | | | | 1 | | 10 | |
| 492 | 492.1 | BBBB | 48 | 12 | 12 | RIB037 | 4 | C1 | C2 | C3 | C4 | 4 | | | 1 | 1 | | 1 | 1 | 1 | | 10 | |
| 492 | 492.1 | BBBB | 24 | 12 | 12 | RIB041 | 2 | C1 | C2 | | | 2 | | | 1 | | | 1 | | 1 | | 10 | |
| 492 | 492.1 | BBBB | 12 | 12 | 12 | RIB079 | 1 | C | | | | 1 | | | | | 1 | | | 1 | | 10 | |
| 492 | 492.1 | BBBB | 24 | 12 | 12 | RIB137 | 2 | C1 | C2 | | | 2 | | | 2 | | | | | 1 | | 10 | |
| 492 | 492.1 | BBBB | 24 | 12 | 12 | RIB141 | 2 | C1 | C2 | | | 2 | | | 2 | | | | | 1 | | 10 | |
| 492 | 492.1 | BBBB | 12 | 12 | 12 | TFL051 | 1 | C | | | | 1 | | | | 1 | | | | 1 | | 10 | |
| 492 | 492.1 | BBBB | 12 | 12 | 12 | TFL052 | 1 | C | | | | 1 | | | | 1 | | | | 1 | | 10 | |
| 492 | 492.1 | BBBB | 12 | 12 | 12 | TFL064 | 1 | C | | | | 1 | | | | 1 | | | | 1 | | 10 | |
| 492 | 492.1 | BBBB | 48 | 12 | 12 | BRI056 | 4 | N1 | N2 | N3 | N4 | 4 | | | | 1 | 1 | 1 | 1 | 2 | | 10 | 28 |
| 492 | 492.1 | BBBB | 48 | 12 | 12 | BRI057 | 4 | P1 | P2 | P3 | P4 | 4 | | | | 1 | 1 | 1 | 1 | 1 | | 10 | |
| 492 | 492.1 | BBBB | 12 | 12 | 12 | ARM006 | 1 | C | | | | 1 | | | | | | 1 | | 1 | | 10 | |
| 492 | 492.1 | BBBB | 12 | 12 | 12 | FQSHIN | 1 | C | | | | 1 | | | | | | 1 | | 1 | | 10 | |
| 492 | 492.1 | BBBB | 12 | 12 | 12 | HQSHIN | 1 | C | | | | 1 | | | | | | 1 | | 1 | | 10 | |

***Figure 3. Portion of CUD Acquisition Sheet allocating Primal ID for cut collection from one side at boning.***

| GroupComment | Group | AnimalID | CUD ref | Works Body No. | Side | Hang | Stim | Primal | Primal ID |
|---|---|---|---|---|---|---|---|---|---|
| BBBB | 492.1 | | 1 | 100 | L | AT | LVES | BLD | 52317 |
| BBBB | 492.1 | | 1 | | L | AT | LVES | CTR | 52318 |
| BBBB | 492.1 | | 1 | | L | AT | LVES | STR | 52319 |
| BBBB | 492.1 | | 1 | | L | AT | LVES | OYS | 52320 |
| BBBB | 492.1 | | 1 | | L | AT | LVES | CHK | 52321 |
| BBBB | 492.1 | | 1 | | L | AT | LVES | RIB | 52322 |
| BBBB | 492.1 | | 1 | | L | AT | LVES | TFL | 52323 |
| BBBB | 492.1 | | 1 | | L | AT | LVES | BRI | 52324 |
| BBBB | 492.1 | | 1 | | L | AT | LVES | FQS | 52325 |
| BBBB | 492.1 | | 1 | | L | AT | LVES | HQS | 52326 |
| BBBB | 492.1 | | 1 | | L | AT | LVES | INT | 52327 |
| | | | | | | | | | |
| BBBB | 492.1 | | 1 | 100 | L | AT | LVES | TDR | 52328 |
| BBBB | 492.1 | | 1 | | L | AT | LVES | RMP | 52329 |
| BBBB | 492.1 | | 1 | | L | AT | LVES | KNU | 52330 |
| BBBB | 492.1 | | 1 | | L | AT | LVES | OUT | 52331 |
| BBBB | 492.1 | | 1 | | L | AT | LVES | EYE | 52332 |
| BBBB | 492.1 | | 1 | | L | AT | LVES | TOP | 52333 |

To maximise the number of samples within budget parameters it was elected to collect cuts from both carcase sides, where muscles were either small or which were poorly represented or non-existent in the AUSBlue database. The upper portion of *Figure 3* lists those collected from both sides.

The cuts at the lower portion of *Figure 3* were well represented in existing data and were only collected from a single side to provide connection, while reducing cost. The cube roll was not included, as the striploin was regarded as an adequate representation of the *M.longissimus* muscle. Sides were alternated for the single cut collection.

For each collection a written instruction regarding cuts required, boning specification, transport and billing arrangements was emailed to the plant prior to the kill date. An example is shown in *Figure 4*.

Laminated 20 x 8 cm brightly coloured tickets were then produced to identify carcase sides with the tickets prominently displaying a CUD number of 1 to 18 and LEFT or RIGHT. The tickets were secured to the loin by 150mm stainless steel pins to provide highly visible identification for sorting from the chiller and through the boning process. At a later point the actual plant body numbers were substituted for the CUD number within AUSBlue.

***Figure 4. Example list of primals required as advised to the plant.***

**Primals to collect**

| **Primals (to collect from 18 carcases)** | **Pieces per body (left & right sides)** | **Piece Count** |
|---|---|---|
| Blade (subscap retained) | 2 | 36 |
| Chuck tender | 2 | 36 |
| Full chuck including neck | 2 | 36 |
| Ribset (Fleece only, we do not want the cube roll) | 2 | 36 |
| Short ribs | 2 | 36 |
| Full brisket (if size permits otherwise NE & PE with deckle retained) | 2 | 36 |
| Thin Flank (flank steak, internal & external flank plates) | 2 | 36 |
| FQ Shin | 2 | 36 |
| HQ Shin | 2 | 36 |
| Striploin | 2 | 36 |
| Silverside (outside flat, eyeround & heel) | 1 | 18 |
| Rump | 1 | 18 |
| Knuckle | 1 | 18 |
| Topside | 1 | 18 |
| Tenderloin s/s off | 1 | 18 |

A further set of laminated coloured labels, 50 x 50 mm, were produced with each continuing ID for each primal. A representative portion of a Primal label file is shown in *Figure 5*. Each label includes the carcase CUD number and side (2 R in the example) and a further unique 5 digit number that was used in subsequent primal fabrication to consumer samples. Research personnel were positioned at boning stations to observe boning and to note the CUD ID on the large carcase side tickets. As a required cut was boned and sliced the related Primal ticket for that cut was placed within the vacuum bag to maintain ID.

The primals were chilled overnight and then transported by refrigerated transport to the University of New England (UNE) meat laboratory for fabrication into consumer samples.

The same procedures were utilised for each of the three collections other than carcase quarter tickets being utilised to suit the quarter chain boning in Tasmania. For this collection, cuts were shipped to Melbourne after collection and moved by road transport to Armidale.

***Figure 5. Example of Primal Labels used to maintain cut ID***

| | | |
|---|---|---|
| **52362**<br>**Body #2 R**<br>**BLADE** | **52365**<br>**Body #2 R**<br>**OYSTER BLADE** | **52369**<br>**Body #2 R**<br>**BRISKET** |
| **52363**<br>**Body #2 R**<br>**CHUCK TENDER** | **52366**<br>**Body #2 R**<br>**CHUCK** | **52372**<br>**Body #2 R**<br>**INTERCOSTALS** |
| **52364**<br>**Body #2 R**<br>**STRIPLOIN** | **52368**<br>**Body #2 R**<br>**THIN FLANK** | |

### 3.1.2 MSA Sample preparation

All fabrication of consumer samples from the collected primals was conducted in the UNE meat laboratory by research and University personnel. Fabrication was conducted according to MSA protocols (Gee, 2006 and summarised in Anon, 2008).

In brief each primal was removed from vacuum packaging and placed on a tray with its identifying ticket. For some primals, particularly the chucks and briskets which had often been cut into pieces post collection due to carton size or weight limits, this required carefully aligning the portions in order to follow muscle seams. The butchers then fully denuded each primal including silverskin and separated the component muscles where appropriate. The denuded single muscle portions were then placed back on a tray/s with the identifying Primal ticket and passed to a recording station.

Further CUD software files were utilised by the recorder to relate the Primal ticket ID with subsequent EQSRef individual sample ID for each portion nominated within each of the muscles and positions within all muscles from that primal. An example of the CutUpSheet control file is shown in *Figure 6* and a portion of the associated CutUpLabels Avery 7160 self adhesive label file displayed in *Figure 7*. Both were printed and bound prior to commencing the cutup.

The Primal Ticket 5 digit number was referenced in the CutUpSheet control file which provided detail of all consumer sample sets to be prepared from each muscle and position within the source primal.

***Figure 6. Portion of the CUD CutUpSheet file***

| Seq | EQS | Primal | Cut | Cook | Age | Pos | Kill | Obj | Check |
|---|---|---|---|---|---|---|---|---|---|
| AUS91432 | P3Y8 | 52317 | BLD088 | GRL | 10 | C | Thu 23 Feb 17 | y | |
| AUS91622 | H0A0 | 52317 | BLD096 | RST | 10 | C1 | Thu 23 Feb 17 | | |
| AUS92251 | F4Q8 | 52317 | BLD084 | SFR | 10 | C | Thu 23 Feb 17 | y | |
| AUS92252 | Q6Q4 | 52317 | BLD095 | SFR | 10 | C | Thu 23 Feb 17 | y | |
| AUS92610 | K9C0 | 52317 | BLD096 | YAK | 10 | T | Thu 23 Feb 17 | y | |
| AUS92611 | T7E6 | 52317 | BLD096 | YAK | 10 | C2 | Thu 23 Feb 17 | | |
| AUS91623 | K6J3 | 52318 | CTR085 | RST | 10 | H | Thu 23 Feb 17 | y | |
| AUS91803 | E8B7 | 52318 | CTR085 | SC2 | 28 | T | Thu 23 Feb 17 | | |

In the *Figure 6* example a Blade primal, with a primal number ID of 52317 is to be fabricated into 4 muscles and further to 6 consumer samples. The recorder checked that the 4 muscles (BLD088, BLD096, BLD084 and BLD095) had been prepared by the butchers and arranged them in a standard orientation on the tray. Another primal, a chuck tender with a Primal Ticket number of 52318 then follows specifying 2 samples to be prepared from a single muscle. Where an objective sample for laboratory use is required a Y is present in the Obj column.

The 52317 Primal number was then referenced in the CutUpLabels, displayed in *Figure 7*, which carried information related to each row of the CutUpSheet. The labels were removed and lightly attached to the tray edge with the position (C, C1, T, C2 or H in the example) aligned with the muscle as laid out on the tray. Additional labels indicated that spare muscle was to be collected for objective laboratory analysis.

After marking the CutUpSheet Check column to record that a sample had been obtained the tray and labels was passed to slicers equipped with a cutting jig and sample blocks to indicate the required size and grain direction for each cooking method. The cutting jig was set to 25mm for samples designated as GRL (grill).

The slicer utilised the labels as instruction on muscle fabrication with the position designating the location of each sample within the muscle and the cook code SC2 requiring preparation of 22 cubes of standard size, SFR a standard size and shape muscle portion for subsequent slicing, GRL five individual 70 x 35 mm x 25 mm thick steaks and so on.

***Figure 7. Self adhesive labels produced from the CUD CutUpLabels file***

| | | |
|---|---|---|
| 52317 | OBJECTIVE<br>52317 - BLD084<br>F4Q8  0503 | AUS92251   F4Q8<br>52317 SFR C<br>BLD084 0503 |
| OBJECTIVE<br>52317 - BLD088<br>P3Y8  0503 | AUS91432   P3Y8<br>52317 GRL C<br>BLD088 0503 | OBJECTIVE<br>52317 - BLD095<br>Q6Q4  0503 |
| AUS92252   Q6Q4<br>52317 SFR C<br>BLD095 0503 | AUS91622   H0A0<br>52317 RST C1<br>BLD096 0503 | OBJECTIVE<br>52317 - BLD096<br>K9C0  0503 |
| AUS92610   K9C0<br>52317 YAK T<br>BLD096 0503 | AUS92611   T7E6<br>52317 YAK C2<br>BLD096 0503 | 52318 |
| OBJECTIVE<br>52318 - CTR085<br>K6J3  0503 | AUS91623   K6J3<br>52318 RST H<br>CTR085 0503 | AUS91803   E8B7<br>52318 SC2 T<br>CTR085 2303 |

If a sample could not be fabricated the label was returned to the recorder who marked the CutUpFile accordingly.

The tray, complete with all fabricated samples, self adhesive labels and original Primal Ticket, was then passed to packers who placed each label on a vacuum pouch and packed the associated sample within the pouch which was then vacuum sealed. Each of the 5 steaks within a grill sample were individually wrapped in freezer wrap to prevent them sticking together when frozen.

The labels again provided instruction for sorting post sealing with the 4 digit code in the right bottom label corner designating a freeze on date. Samples were sorted into freeze down dates within cooking method. They were stored chilled until freezing date then laid single depth for rapid freezing. Post freezing samples were packed in foam and stored at -20˚C.

The unique Sequence and EQSRef codes assigned by the CUD software formed the primary identification for all subsequent sample management through to the individual consumer plate ID labels.

*Table 6* presents the number of consumer samples fabricated from each of the 3 BIN collections, in all 7261 representing 67 individual source muscles, 26 of which had not been previously tested and identified within the “NEW” column. The 5 cook types presented in *Table 6* summarise further subdivisions of Osso Bucco (OSO) and Sous-Vide (SVD) within the SC2 counts and moist heat roasting (COM) plus bone-in and boneless forms within the RST counts.

*Table 6. Consumer samples fabricated by muscles and primary cook method from 3 BIN collections.*

| | | | NORTHERN BIN | | | | | | HEREFORD BIN | | | | | | ANGUS BIN | | | | | | ALL BIN GROUPS | | | | | | NEW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MUSCLE | CODE | Bone | GRL | RST | SC2 | SFR | YAK | TOTAL | GRL | RST | SC2 | SFR | YAK | TOTAL | GRL | RST | SC2 | SFR | YAK | TOTAL | GRL | RST | SC2 | SFR | YAK | TOTAL | |
| M.deltoideus | BLD011 | | | | | | | | | | | | | | | | 16 | | 16 | **32** | 0 | 0 | 16 | 0 | 16 | **32** | Y |
| M.latissimus dorsi | BLD041 | | | | | | | | | | | | | | | | 36 | | | **36** | 0 | 0 | 36 | 0 | 0 | **36** | |
| M.subscapularis | BLD084 | | | | 9 | 18 | 9 | **36** | | | 12 | 12 | 12 | **36** | | | 12 | 11 | 11 | **34** | 0 | 0 | 33 | 41 | 32 | **106** | Y |
| M.teres major | BLD088 | | 34 | | | | | **34** | 18 | | | | | **18** | 16 | | | | | **16** | 68 | 0 | 0 | 0 | 0 | **68** | |
| M.triceps brachii caput laterale | BLD095 | | | | | 36 | | **36** | | | | 36 | | **36** | | | 12 | 12 | 12 | **36** | 0 | 0 | 12 | 84 | 12 | **108** | |
| M.triceps brachii caput longum | BLD096 | | 6 | 12 | 30 | 12 | 12 | **72** | 6 | 24 | 24 | 6 | 12 | **72** | 12 | 24 | 13 | 11 | 12 | **72** | 24 | 60 | 67 | 29 | 36 | **216** | |
| M.triceps brachii caput mediale | BLD097 | | | | 18 | 9 | 9 | **36** | | | 24 | 6 | 6 | **36** | | | 12 | 12 | 12 | **36** | 0 | 0 | 54 | 27 | 27 | **108** | Y |
| M.pectoralis profundus | BRI056 | | | 36 | 72 | | | **108** | | 34 | 80 | 7 | 14 | **135** | | 36 | 90 | 9 | 9 | **144** | 0 | 106 | 242 | 16 | 23 | **387** | |
| M.pectoralis superficialis | BRI057 | | | | 36 | 17 | 17 | **70** | | | 58 | 16 | 14 | **88** | | | 36 | 18 | 18 | **72** | 0 | 0 | 130 | 51 | 49 | **230** | |
| M.brachiocephalicus | CHK007 | | | | | | | | | | | | | | | | 27 | | | **27** | 0 | 0 | 27 | 0 | 0 | **27** | Y |
| M.intercostales externus and internus | CHK037 | | | | | | | | | 1 | | | | **1** | | | | | | | 0 | 1 | 0 | 0 | 0 | **1** | Y |
| M.latissimus dorsi | CHK041 | | | 1 | 1 | | | **2** | | | | | | | | | | | | | 0 | 1 | 1 | 0 | 0 | **2** | Y |
| M.longus colli | CHK047 | | | | 3 | | | **3** | | | 6 | | | **6** | | | 36 | | | **36** | 0 | 0 | 45 | 0 | 0 | **45** | Y |
| M.multifidi cervicis | CHK048 | | | | 25 | | | **25** | | | 26 | | | **26** | | | 36 | | | **36** | 0 | 0 | 87 | 0 | 0 | **87** | Y |
| M.pectoralis profundus | CHK056 | | | | | | | | | | | | | | | | | | 9 | **9** | 0 | 0 | 0 | 0 | 9 | **9** | Y |
| M.rhomboideus | CHK068 | | | | 72 | | | **72** | | | 53 | | | **53** | | | 65 | | | **65** | 0 | 0 | 190 | 0 | 0 | **190** | |
| M.semispinalis capitis | CHK074 | | 7 | 7 | 14 | | 7 | **35** | 6 | 3 | 21 | 3 | 3 | **36** | 12 | 18 | 34 | | | **64** | 25 | 28 | 69 | 3 | 10 | **135** | |
| M.serratus ventralis cervicis | CHK078 | | 9 | 26 | 36 | | 18 | **89** | 29 | 24 | 37 | | 18 | **108** | 9 | 17 | 45 | 18 | 27 | **116** | 47 | 67 | 118 | 18 | 63 | **313** | |
| M.spinalis dorsi | CHK081 | | 9 | | 9 | 9 | 9 | **36** | 9 | | 9 | 9 | 9 | **36** | 9 | | 9 | 9 | 9 | **36** | 27 | 0 | 27 | 27 | 27 | **108** | |
| M.splenius | CHK082 | | | | 18 | 18 | | **36** | | | 18 | 17 | | **35** | | | 18 | 18 | | **36** | 0 | 0 | 54 | 53 | 0 | **107** | |
| M.trapezius cervicalis | CHK093 | | | | | | | | | | | | | | | | 36 | | | **36** | 0 | 0 | 36 | 0 | 0 | **36** | Y |
| M.intercostales externus and internus | CHK137 | Y | | 18 | | | | **18** | | 18 | | | | **18** | | 18 | | | | **18** | 0 | 54 | 0 | 0 | 0 | **54** | Y |
| M.pectoralis profundus | CHK156 | Y | | 9 | | | | **9** | | 9 | | | | **9** | | 9 | | | | **9** | 0 | 27 | 0 | 0 | 0 | **27** | Y |
| M.serratus ventralis cervicis | CHK178 | Y | | 9 | | | | **9** | | 9 | | | | **9** | | 9 | | | | **9** | 0 | 27 | 0 | 0 | 0 | **27** | Y |
| M.pectoralis profundus | CHK256 | | | 9 | | | | **9** | | 9 | | | | **9** | | 9 | | | | **9** | 0 | 27 | 0 | 0 | 0 | **27** | Y |
| M.serratus ventralis cervicis | CHK278 | | | 9 | | | | **9** | | 9 | | | | **9** | | 9 | | | | **9** | 0 | 27 | 0 | 0 | 0 | **27** | Y |
| M.intercostales externus and internus | CHK337 | | | 16 | | | | **16** | | 18 | | | | **18** | | 18 | | | | **18** | 0 | 52 | 0 | 0 | 0 | **52** | Y |
| M.supraspinatus | CTR085 | | 3 | 15 | 54 | | | **72** | 3 | 15 | 52 | | | **70** | 12 | 24 | 35 | | | **71** | 18 | 54 | 141 | 0 | 0 | **213** | |
| M.semitendinosus | EYE075 | | | 18 | 35 | 9 | 9 | **71** | | 18 | 36 | 9 | 9 | **72** | | 12 | 34 | 12 | 12 | **70** | 0 | 48 | 105 | 30 | 30 | **213** | |
| M.biceps brachii | FQS004 | | | | 18 | | | **18** | | | 18 | | | **18** | | | 36 | | | **36** | 0 | 0 | 72 | 0 | 0 | **72** | Y |
| M.brachialis | FQS006 | | | | 17 | | | **17** | | | 17 | | | **17** | | | 36 | | | **36** | 0 | 0 | 70 | 0 | 0 | **70** | Y |
| Flexor/extensor muscle group surrounding the radius | FQSHIN | y | | | 36 | | | **36** | | | 71 | | | **71** | | | 55 | | | **55** | 0 | 0 | 162 | 0 | 0 | **162** | |
| M.peronaeus tertius | HQS059 | | | | 18 | | | **18** | | | 18 | | | **18** | | | 28 | | | **28** | 0 | 0 | 64 | 0 | 0 | **64** | Y |
| Muscle group surrounding the tibia | HQSHIN | y | | | 36 | | | **36** | | | 64 | | | **64** | | | 56 | | | **56** | 0 | 0 | 156 | 0 | 0 | **156** | |
| M.intercostales externus and internus | INT037 | | | 31 | | 14 | | **45** | | 25 | 5 | 1 | | **31** | | 35 | 18 | 18 | | **71** | 0 | 91 | 23 | 33 | 0 | **147** | |
| M.intercostales externus and internus | INT237 | | | 36 | | | | **36** | | 36 | | | | **36** | | 36 | | | | **36** | 0 | 108 | 0 | 0 | 0 | **108** | Y |
| M.rectus femoris | KNU066 | | | 18 | 18 | | | **36** | | 18 | 18 | | | **36** | | 18 | 18 | | | **36** | 0 | 54 | 54 | 0 | 0 | **108** | |
| M.vastus intermedius | KNU098 | | | | 8 | 9 | | **17** | | | 9 | 9 | | **18** | | | 9 | 9 | | **18** | 0 | 0 | 26 | 27 | 0 | **53** | |
| M.vastus lateralis | KNU099 | | | 18 | 35 | | 9 | **62** | | 18 | 35 | | 4 | **57** | | 18 | 36 | | 9 | **63** | 0 | 54 | 106 | 0 | 22 | **182** | |

| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M.vastus medialis | KNU100 | | | | | 9 | 9 | 18 | | | | 9 | 9 | 18 | | | | 9 | 9 | 18 | 0 | 0 | 0 | 27 | 27 | 54 | |
| M.biceps femoris (syn. gluteobiceps) | OUT005 | | 9 | 18 | 36 | | 9 | 72 | 11 | 18 | 36 | | 9 | 74 | 7 | 18 | 36 | | 9 | 70 | 27 | 54 | 108 | 0 | 27 | 216 | |
| M.flexor digitorum sublimis | OUT027 | | | | | | | | | | | | | | | | 12 | | | 12 | 0 | 0 | 12 | 0 | 0 | 12 | Y |
| M.gastrocnemius | OUT029 | | | 18 | 18 | | | 36 | | 18 | 18 | | | 36 | | 17 | 18 | | | 35 | 0 | 53 | 54 | 0 | 0 | 107 | |
| M.infraspinatus | OYS036 | | 23 | 23 | 20 | 13 | 11 | 90 | 27 | 27 | 12 | 15 | 9 | 90 | 24 | 24 | 18 | 12 | 12 | 90 | 74 | 74 | 50 | 40 | 32 | 270 | |
| M.latissimus dorsi | RIB041 | | | | | | | | | | 9 | | 9 | 18 | | | 18 | 9 | 9 | 36 | 0 | 0 | 27 | 9 | 18 | 54 | |
| M.serratus ventralis thoracis | RIB078 | | | | 4 | 9 | 7 | 20 | | | | | | | | | | 9 | 9 | 18 | 0 | 0 | 4 | 18 | 16 | 38 | |
| M.intercostales externus and internus | RIB137 | y | | 18 | | | | 18 | | 18 | | | | 18 | | 18 | | | | 18 | 0 | 54 | 0 | 0 | 0 | 54 | Y |
| M.latissimus dorsi | RIB141 | y | | 18 | | | | 18 | | 18 | | | | 18 | | 18 | | | | 18 | 0 | 54 | 0 | 0 | 0 | 54 | Y |
| M.latissimus dorsi | RIB241 | | | 18 | | | | 18 | | 18 | | | | 18 | | 18 | | | | 18 | 0 | 54 | 0 | 0 | 0 | 54 | Y |
| M.intercostales externus and internus | RIB337 | | | 20 | | | | 20 | | 18 | | | | 18 | | 18 | | | | 18 | 0 | 56 | 0 | 0 | 0 | 56 | Y |
| M.biceps femoris (syn. gluteobiceps) | RMP005 | | 9 | 9 | | 9 | 9 | 36 | 5 | 6 | | 12 | 11 | 34 | 8 | 7 | | 9 | 8 | 32 | 22 | 22 | 0 | 30 | 28 | 102 | |
| M.gluteus accessorius | RMP030 | | | | | | | | | | | 11 | 1 | 12 | | | | 7 | | 7 | 0 | 0 | 0 | 18 | 1 | 19 | |
| M.gluteus profundus | RMP032 | | | | | 9 | 9 | 18 | | | 3 | | | 3 | | | | | | | 0 | 0 | 3 | 9 | 9 | 21 | |
| M.tensor fasciae latae | RMP087 | | | 6 | | 6 | 6 | 18 | | | | | | | 4 | 5 | | 7 | 2 | 18 | 4 | 11 | 0 | 13 | 8 | 36 | |
| M.gluteus medius | RMP131 | | 9 | 18 | | 9 | 9 | 45 | 10 | 16 | | 8 | 9 | 43 | 9 | 18 | | 9 | 9 | 45 | 28 | 52 | 0 | 26 | 27 | 133 | |
| M.gluteus medius | RMP231 | | 9 | 18 | | 9 | 9 | 45 | 3 | 15 | | 9 | 9 | 36 | 4 | 18 | | 7 | 7 | 36 | 16 | 51 | 0 | 25 | 25 | 117 | |
| M.longissimus dorsi | STR045 | | 67 | 36 | 72 | | | 175 | 72 | 36 | 72 | | | 180 | 36 | 67 | 36 | 18 | 18 | 175 | 175 | 139 | 180 | 18 | 18 | 530 | |
| M.multifidi cervicis | STR049 | | | | | | | | | | | | | | | | 17 | | | 17 | 0 | 0 | 17 | 0 | 0 | 17 | Y |
| M.iliacus | TDR034 | | 18 | | | | | 18 | 18 | | | | | 18 | 18 | | | | | 18 | 54 | 0 | 0 | 0 | 0 | 54 | |
| M.psoas major | TDR062 | | 12 | 36 | | 12 | 12 | 72 | 3 | 36 | | 7 | 12 | 58 | 9 | 34 | | 9 | 8 | 60 | 24 | 106 | 0 | 28 | 32 | 190 | |
| M.obliquus externus abdominis | TFL051 | | | | 12 | 12 | 12 | 36 | | | 12 | 12 | 12 | 36 | | | 12 | 12 | 12 | 36 | 0 | 0 | 36 | 36 | 36 | 108 | |
| M.obliquus internus abdominis | TFL052 | | | | 12 | 12 | 12 | 36 | | | 12 | 12 | 12 | 36 | | | 12 | 12 | 12 | 36 | 0 | 0 | 36 | 36 | 36 | 108 | |
| M.rectus abdominis | TFL064 | | | | 12 | 12 | 12 | 36 | | | 12 | 11 | 12 | 35 | | | 12 | 12 | 12 | 36 | 0 | 0 | 36 | 35 | 36 | 107 | |
| M.adductor femoris | TOP001 | | | | 12 | 12 | 12 | 36 | | | 12 | 11 | 11 | 34 | | | 12 | 12 | 12 | 36 | 0 | 0 | 36 | 35 | 35 | 106 | |
| M.gracilis | TOP033 | | | | 36 | | | 36 | | | | | | | | | 36 | | | 36 | 0 | 0 | 72 | 0 | 0 | 72 | |
| M.pectineus | TOP055 | | | | | 9 | 9 | 18 | | | | | | | | | | 9 | 9 | 18 | 0 | 0 | 0 | 18 | 18 | 36 | |
| M.semimembranosus | TOP073 | | 18 | 36 | 72 | | 18 | 144 | 17 | 34 | 67 | | 17 | 135 | 18 | 36 | 72 | | 18 | 144 | 53 | 106 | 211 | 0 | 53 | 423 | |
| | **TOTAL** | | **242** | **580** | **924** | **293** | **264** | **2303** | **237** | **566** | **976** | **248** | **243** | **2270** | **207** | **626** | **1205** | **319** | **331** | **2688** | **686** | **1772** | **3105** | **860** | **838** | **7261** | **26** |

Further detail on the cooking methods utilised within the HAM code and muscle subdivisions is provided in *Table 7*. A greater breakdown of ageing periods by BIN group is available in *Table 8*. The variation in first ageing dates relates to the logistics of transport time to have meat available at UNE post kill and also to the extreme volume of samples fabricated. Where possible cuts known to have higher ageing rates were fabricated first to provide maximum ageing variation relative to the 28 day final benchmark.

After fabrication the CUD CutUpSheet files were processed to confirm all samples that were successfully prepared, identify any that were not obtained or modify any that were incorrectly cut or frozen on a different date. These files were then transferred by the final CUD software step into the AUSBlue database and marked Available enabling their selection for sensory testing.

***Table 7. Cooking methods utilised within muscle and source primal cut from 3 BIN cut collections***

| Cut & HAM Collected | Cut Derivatives & HAM | MSA Code | HAM | M. | H.A.M. Muscle Name | COOK CODES PREPARED |
|---|---|---|---|---|---|---|
| **CHUCK 2260** | | CHK007 | 7 | M. | brachiocephalicus | SC2 |
| | | CHK041 | 41 | M. | latissimus dorsi | COM, SC2 |
| | Neck chain 2460 | CHK047 | 47 | M. | longus colli | SC2 |
| Needs to be left on during dressing | | CHK048 | 48 | M. | multifidi cervicis | SC2 |
| | | CHK056 | 56 | M. | pectoralis profundus | YAK |
| | Chuck crest 2278 | CHK068 | 68 | M. | rhomboideus | SC2, SVD |
| | | CHK074 | 74 | M. | semispinalis capitis | GRL, RST, SC2, SFR, SVD, YAK |
| | | CHK078 | 78 | M. | serratus ventralis cervicis | COM, GRL, RST, SC2, SFR, SVD, YAK |
| | | CHK081 | 81 | M. | spinalis dorsi | GRL, SC2, SFR, YAK |
| | | CHK082 | 82 | M. | splenius | SC2, SFR |
| | | CHK093 | 93 | M. | trapezius cervicalis | SC2 |
| | Spare ribs 1695 | *CHK137* | *37* | *M.* | *intercostales externus and internus* | COM, RST |
| | Chuck short ribs 1631 | *CHK156* | *56* | *M.* | *pectoralis profundus* | COM, RST |
| | Chuck short ribs 1631/Chuck rib meat 1696 | *CHK178* | *78* | *M.* | *serratus ventralis cervicis* | COM, RST |
| | | *INT237* | *37* | *M.* | *intercostales externus and internus* | COM, RST |
| | Chuck rib meat 2640/chuck meat square 2645 | *CHK256* | *56* | *M.* | *pectoralis profundus* | COM, RST |
| | Chuck rib meat 2640/chuck meat square 2645 | *CHK278* | *78* | *M.* | *serratus ventralis cervicis* | COM, RST |
| | | *CHK337* | *37* | *M.* | *intercostales externus and internus* | COM, RST |
| **CHUCK TENDER 2310** | Chuck Tender 2310 | CTR085 | 85 | M. | supraspinatus | COM, GRL, RST, SC2, SVD |
| **BLADE 2300** | | BLD011 | 11 | M. | deltoideus | SC2, YAK |
| | | BLD041 | 41 | M. | latissimus dorsi | SC2 |
| | Blade Undercut 2304 | BLD084 | 84 | M. | subscapularis | SC2, SFR, YAK |
| | | BLD088 | 88 | M. | teres major | GRL |
| | Bolar Blade 2302 | BLD095 | 95 | M. | triceps brachii caput laterale | SC2, SFR, YAK |
| | Bolar Blade 2302 | BLD096 | 96 | M. | triceps brachii caput longum | COM, GRL, RST, SC2, SFR, SVD, YAK |
| | Bolar Blade 2302 | BLD097 | 97 | M. | triceps brachii caput mediale | SC2, SFR, SVD, YAK |
| **OYSTER BLADE 2304** | Oyster Blade 2304 | OYS036 | 36 | M. | infraspinatus | COM, FLT, GRL, RST, SC2, SFR, SVD, YAK |
| **RIBSET 2223** | Intercostals 2430 | INT037 | 37 | M. | intercostales externus and internus | COM, RST, SC2, SFR |
| | Rib cap 2470 | RIB041 | 41 | M. | latissimus dorsi | SC2, SFR, SVD, YAK |
| | Short rib meat 2465 | RIB078 | 79 | M. | serratus ventralis thoracis | SC2, SFR, YAK |
| | Spare ribs 1695 | *RIB137* | *37* | *M.* | *intercostales externus and internus* | COM, RST |
| | Short ribs 1694 | *RIB141* | *41* | *M.* | *latissimus dorsi* | COM, RST |
| | | *INT237* | *37* | *M.* | *intercostales externus and internus* | COM, RST |
| | Rib meat square 2650 | *RIB241* | *41* | *M.* | *latissimus dorsi* | COM, RST |
| | | *RIB337* | *37* | *M.* | *intercostales externus and internus* | COM, RST |
| **BRISKET 2323** | | BRI056 | 56 | M. | pectoralis profundus | COM, RST, SC2, SFR, SVD, YAK |
| | | BRI057 | 57 | M. | pectoralis superficialis | SC2, SFR, SVD, YAK |
| **FQ Shin 1682** | Shin/shank forequarter 1682/2360/2365/Group F | FQSHIN | Flexor/extensor muscle group surrounding | | | SC2, OSO |
| | Armbone shin 1685/ Shin special trim C conical muscle | FQS004 | 4 | M. | biceps brachii | SC2, SVD, |
| | Armbone shin 1685/ Shin special trim E | FQS006 | 6 | M. | brachialis | SC2, SVD, |
| **TENDERLOIN 2150** | Butt Tenderloin 2170 | TDR034 | 34 | M. | iliacus | GRL |
| | Tenderloin 2150 | TDR062 | 62 | M. | psoas major | COM, GRL, RST, SFR, YAK |
| **STRIPLOIN 2140** | | STR045 | 45 | M. | longissimus dorsi | COM, GRL, RST, SC2, SFR, SVD, YAK |
| | | STR048 | 48 | M. | multifidi cervicis | SC2 |
| **RUMP 2090** | Rump Cap 2091 | RMP005 | 5 | M. | biceps femoris (syn. gluteobiceps) | GRL, RST, SFR, YAK |
| | | RMP030 | 30 | M. | gluteus accessorius | SFR, YAK |
| | | RMP032 | 32 | M. | gluteus profundus | SC2, SFR, YAK |
| | Tri-Tip 2131 | RMP087 | 87 | M. | tensor fasciae latae | GRL, RST, SFR, YAK |
| | Rostbiff 2110/D-Rump 2100 (sets grade for both) | RMP131 | 31 | M. | gluteus medius | COM, GRL, RST, SFR, YAK |
| | Rostbiff 2110 | RMP231 | 31 | M. | gluteus medius | COM, GRL, RST, SFR, YAK |
| **SILVERSIDE 2020** | Outside Flat 2050/Outside meat 2033 | OUT005 | 5 | M. | biceps femoris (syn. gluteobiceps) | COM, GRL, RST, SC2, SFR, SVD, YAK |
| | FDS | OUT027 | 27 | M. | flexor Digitorum Superficialis | SC2 |
| | Heel Special Trim 2365 Group B | OUT029 | 29 | M. | gastrocnemius | COM, RST, SC2, SVD |
| **EYE ROUND 2040** | Eye Round 2040/Inside meat 2035 | EYE075 | 75 | M. | semitendinosus | COM, RST, SC2, SFR, SVD, YAK |
| **TOPSIDE 2000** | | TOP001 | 1 | M. | adductor femoris | SC2, SFR, YAK |
| | Topside Cap 2002 | TOP033 | 33 | M. | gracilis | SC2, SVD |
| | | TOP055 | 55 | M. | pectineus | SFR, YAK |
| | Cap off Topside 2001/Inside meat 2035 | TOP073 | 73 | M. | semimembranosus | COM, GRL, RST, SC2, SVD, YAK |
| **KNUCKLE 2070** | M.rectus femoris 2067 | KNU066 | 66 | M. | rectus femoris | COM, RST, SC2, SVD |
| | M.vastus intermedius 2069 | KNU098 | 98 | M. | vastus intermedius | SC2, SFR |
| | M. vastus lateralis 2068 | KNU099 | 99 | M. | vastus lateralis | COM, RST, SC2, SVD, YAK |
| | | KNU100 | 100 | M. | vastus medialis | SFR, YAK |
| **THIN FLANK 2200** | External flank Plate 2204 | TFL051 | 51 | M. | obliquus externus abdominis | SC2, SFR, YAK |
| | Internal Flank Plate 2203 & Flap Meat 2206 | TFL052 | 52 | M. | obliquus internus abdominis | SC2, SFR, YAK |
| | Flank Steak 2210 | TFL064 | 64 | M. | rectus abdominis | SC2, SFR, YAK |
| **HQ Shank** | Shin/shank hindquarter 1683/2360/2365 Group A/D | HQSHIN | Muscle group surrounding the tibia | | | OSO, SC2 |
| | Shin/shank hindquarter 1683/2360/2365 Group A | HQS059 | 59 | M. | peronaeus tertius | SC2, SVD |

***Table 8. Ageing periods applied by muscle within three BIN cut collections***

| Days Aged | NORTHERN BIN | | | | | | HEREFORD BIN | | | | ANGUS BIN | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7 | 8 | 10 | 11 | 28 | TOTAL | 7 | 8 | 28 | TOTAL | 4 | 28 | TOTAL |
| BLD011 | | | | | | | | | | | 18 | 14 | 32 |
| BLD041 | | | | | | | | | | | 18 | 18 | 36 |
| BLD084 | | 36 | | | | 36 | 27 | | 9 | 36 | 18 | 16 | 34 |
| BLD088 | | 34 | | | | 34 | 18 | | | 18 | 16 | | 16 |
| BLD095 | | 36 | | | | 36 | 18 | | 18 | 36 | 18 | 18 | 36 |
| BLD096 | | 59 | | | 13 | 72 | 48 | | 24 | 72 | 36 | 36 | 72 |
| BLD097 | | 36 | | | | 36 | 18 | | 18 | 36 | 18 | 18 | 36 |
| BRI056 | | 72 | | | 36 | 108 | 83 | | 52 | 135 | 81 | 63 | 144 |
| BRI057 | | 52 | | | 18 | 70 | 56 | | 32 | 88 | 37 | 35 | 72 |
| CHK007 | | | | | | | | | | | 16 | 11 | 27 |
| CHK037 | | | | | | | 1 | | | 1 | | | |
| CHK041 | | | | 2 | | 2 | | | | | | | |
| CHK047 | | 3 | | | | 3 | 2 | | 4 | 6 | 18 | 18 | 36 |
| CHK048 | | | | 24 | 1 | 25 | 12 | | 14 | 26 | 18 | 18 | 36 |
| CHK056 | | | | | | | | | | | 9 | | 9 |
| CHK068 | | 36 | | | 36 | 72 | 26 | | 27 | 53 | 32 | 33 | 65 |
| CHK074 | | 35 | | | | 35 | 26 | | 10 | 36 | 32 | 32 | 64 |
| CHK078 | | 89 | | | | 89 | 72 | | 36 | 108 | 63 | 53 | 116 |
| CHK081 | | 36 | | | | 36 | 24 | | 12 | 36 | 18 | 18 | 36 |
| CHK082 | | 36 | | | | 36 | 23 | | 12 | 35 | 18 | 18 | 36 |
| CHK093 | | | | | | | | | | | 18 | 18 | 36 |
| CHK137 | | 18 | | | | 18 | 18 | | | 18 | 18 | | 18 |
| CHK156 | | 9 | | | | 9 | 9 | | | 9 | 9 | | 9 |
| CHK178 | | 9 | | | | 9 | 9 | | | 9 | 9 | | 9 |
| CHK256 | | 9 | | | | 9 | 9 | | | 9 | 9 | | 9 |
| CHK278 | | 9 | | | | 9 | 9 | | | 9 | 9 | | 9 |
| CHK337 | | 16 | | | | 16 | 18 | | | 18 | 18 | | 18 |
| CTR085 | | 43 | | 2 | 27 | 72 | 43 | | 27 | 70 | 36 | 35 | 71 |
| EYE075 | | | 54 | | 17 | 71 | 54 | | 18 | 72 | 37 | 33 | 70 |
| FQS004 | | | 18 | | | 18 | 9 | | 9 | 18 | 18 | 18 | 36 |
| FQS006 | | | 17 | | | 17 | 8 | | 9 | 17 | 18 | 18 | 36 |
| FQSHIN | 36 | | | | | 36 | 71 | | | 71 | 55 | | 55 |
| HQS059 | 18 | | | | | 18 | 9 | | 9 | 18 | 12 | 16 | 28 |
| HQSHIN | 36 | | | | | 36 | 46 | | 18 | 64 | 56 | | 56 |
| INT037 | | 45 | | | | 45 | 31 | | | 31 | 71 | | 71 |
| INT237 | | 36 | | | | 36 | 36 | | | 36 | 36 | | 36 |
| KNU066 | | | 36 | | | 36 | 36 | | | 36 | 20 | 16 | 36 |
| KNU098 | | | 17 | | | 17 | 18 | | | 18 | 12 | 6 | 18 |
| KNU099 | | | 57 | | 5 | 62 | 39 | | 18 | 57 | 36 | 27 | 63 |
| KNU100 | | | 18 | | | 18 | 18 | | | 18 | 12 | 6 | 18 |
| OUT005 | | | 54 | | 18 | 72 | 50 | | 22 | 72 | 42 | 30 | 72 |
| OUT027 | | | | | | | | | | | 5 | 7 | 12 |
| OUT029 | | | 36 | | | 36 | 36 | | | 36 | 23 | 12 | 35 |
| OYS036 | | 90 | | | | 90 | 90 | | | 90 | 44 | 46 | 90 |
| RIB041 | | | | | | | 18 | | | 18 | 24 | 12 | 36 |
| RIB078 | | 20 | | | | 20 | | | | | 12 | 6 | 18 |
| RIB137 | | 18 | | | | 18 | 18 | | | 18 | 18 | | 18 |
| RIB141 | | 18 | | | | 18 | 18 | | | 18 | 18 | | 18 |
| RIB241 | | 18 | | | | 18 | 18 | | | 18 | 18 | | 18 |
| RIB337 | | 20 | | | | 20 | 18 | | | 18 | 18 | | 18 |
| RMP005 | | | 36 | | | 36 | | 34 | | 34 | 16 | 16 | 32 |
| RMP030 | | | | | | | | 12 | | 12 | 2 | 5 | 7 |
| RMP032 | | | 18 | | | 18 | | 3 | | 3 | | | |
| RMP087 | | | 18 | | | 18 | | | | | 11 | 7 | 18 |
| RMP131 | | | 45 | | | 45 | | 43 | | 43 | 22 | 23 | 45 |
| RMP231 | | | 45 | | | 45 | | 36 | | 36 | 17 | 19 | 36 |
| STR045 | 121 | | | | 54 | 175 | 108 | | 72 | 180 | 103 | 72 | 175 |
| STR049 | | | | | | | | | | | 8 | 9 | 17 |
| TDR034 | | | 18 | | | 18 | 18 | | | 18 | 9 | 9 | 18 |
| TDR062 | | | 72 | | | 72 | 58 | | | 58 | 32 | 28 | 60 |
| TFL051 | | 36 | | | | 36 | 24 | | 12 | 36 | 18 | 18 | 36 |
| TFL052 | | 36 | | | | 36 | 24 | | 12 | 36 | 18 | 18 | 36 |
| TFL064 | | 36 | | | | 36 | 23 | | 12 | 35 | 18 | 18 | 36 |
| TOP001 | | | 36 | | | 36 | 34 | | | 34 | 18 | 18 | 36 |
| TOP033 | | | 36 | | | 36 | | | | | 18 | 18 | 36 |
| TOP055 | | | 18 | | | 18 | | | | | 12 | 6 | 18 |
| TOP073 | | | 108 | | 36 | 144 | 93 | | 42 | 135 | 73 | 71 | 144 |
| | | | | | | | | | | | | | |
| **TOTAL** | **211** | **1046** | **757** | **28** | **261** | **2303** | **1592** | **128** | **548** | **2268** | **1610** | **1080** | **2690** |

| Days Aged | NORTHERN BIN | | | | | | HEREFORD BIN | | | | ANGUS BIN | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7 | 8 | 10 | 11 | 28 | TOTAL | 7 | 8 | 28 | TOTAL | 4 | 28 | TOTAL |
| BLD011 | | | | | | | | | | | 18 | 14 | 32 |
| BLD041 | | | | | | | | | | | 18 | 18 | 36 |
| BLD084 | | 36 | | | | 36 | 27 | | 9 | 36 | 18 | 16 | 34 |
| BLD088 | | 34 | | | | 34 | 18 | | | 18 | 16 | | 16 |
| BLD095 | | 36 | | | | 36 | 18 | | 18 | 36 | 18 | 18 | 36 |
| BLD096 | | 59 | | | 13 | 72 | 48 | | 24 | 72 | 36 | 36 | 72 |
| BLD097 | | 36 | | | | 36 | 18 | | 18 | 36 | 18 | 18 | 36 |
| BRI056 | | 72 | | | 36 | 108 | 83 | | 52 | 135 | 81 | 63 | 144 |
| BRI057 | | 52 | | | 18 | 70 | 56 | | 32 | 88 | 37 | 35 | 72 |
| CHK007 | | | | | | | | | | | 16 | 11 | 27 |
| CHK037 | | | | | | | 1 | | | 1 | | | |
| CHK041 | | | | 2 | | 2 | | | | | | | |
| CHK047 | | 3 | | | | 3 | 2 | | 4 | 6 | 18 | 18 | 36 |
| CHK048 | | | | 24 | 1 | 25 | 12 | | 14 | 26 | 18 | 18 | 36 |
| CHK056 | | | | | | | | | | | 9 | | 9 |
| CHK068 | | 36 | | | 36 | 72 | 26 | | 27 | 53 | 32 | 33 | 65 |
| CHK074 | | 35 | | | | 35 | 26 | | 10 | 36 | 32 | 32 | 64 |
| CHK078 | | 89 | | | | 89 | 72 | | 36 | 108 | 63 | 53 | 116 |
| CHK081 | | 36 | | | | 36 | 24 | | 12 | 36 | 18 | 18 | 36 |
| CHK082 | | 36 | | | | 36 | 23 | | 12 | 35 | 18 | 18 | 36 |
| CHK093 | | | | | | | | | | | 18 | 18 | 36 |
| CHK137 | | 18 | | | | 18 | 18 | | | 18 | 18 | | 18 |
| CHK156 | | 9 | | | | 9 | 9 | | | 9 | 9 | | 9 |
| CHK178 | | 9 | | | | 9 | 9 | | | 9 | 9 | | 9 |
| CHK256 | | 9 | | | | 9 | 9 | | | 9 | 9 | | 9 |
| CHK278 | | 9 | | | | 9 | 9 | | | 9 | 9 | | 9 |
| CHK337 | | 16 | | | | 16 | 18 | | | 18 | 18 | | 18 |
| CTR085 | | 43 | | 2 | 27 | 72 | 43 | | 27 | 70 | 36 | 35 | 71 |
| EYE075 | | | 54 | | 17 | 71 | 54 | | 18 | 72 | 37 | 33 | 70 |
| FQS004 | | | 18 | | | 18 | 9 | | 9 | 18 | 18 | 18 | 36 |
| FQS006 | | | 17 | | | 17 | 8 | | 9 | 17 | 18 | 18 | 36 |
| FQSHIN | 36 | | | | | 36 | 71 | | | 71 | 55 | | 55 |
| HQS059 | 18 | | | | | 18 | 9 | | 9 | 18 | 12 | 16 | 28 |
| HQSHIN | 36 | | | | | 36 | 46 | | 18 | 64 | 56 | | 56 |
| INT037 | | 45 | | | | 45 | 31 | | | 31 | 71 | | 71 |
| INT237 | | 36 | | | | 36 | 36 | | | 36 | 36 | | 36 |
| KNU066 | | | 36 | | | 36 | 36 | | | 36 | 20 | 16 | 36 |
| KNU098 | | | 17 | | | 17 | 18 | | | 18 | 12 | 6 | 18 |
| KNU099 | | | 57 | | 5 | 62 | 39 | | 18 | 57 | 36 | 27 | 63 |
| KNU100 | | | 18 | | | 18 | 18 | | | 18 | 12 | 6 | 18 |
| OUT005 | | | 54 | | 18 | 72 | 50 | | 22 | 72 | 42 | 30 | 72 |
| OUT027 | | | | | | | | | | | 5 | 7 | 12 |
| OUT029 | | | 36 | | | 36 | 36 | | | 36 | 23 | 12 | 35 |
| OYS036 | | 90 | | | | 90 | 90 | | | 90 | 44 | 46 | 90 |
| RIB041 | | | | | | | 18 | | | 18 | 24 | 12 | 36 |
| RIB078 | | 20 | | | | 20 | | | | | 12 | 6 | 18 |
| RIB137 | | 18 | | | | 18 | 18 | | | 18 | 18 | | 18 |
| RIB141 | | 18 | | | | 18 | 18 | | | 18 | 18 | | 18 |
| RIB241 | | 18 | | | | 18 | 18 | | | 18 | 18 | | 18 |
| RIB337 | | 20 | | | | 20 | 18 | | | 18 | 18 | | 18 |
| RMP005 | | | 36 | | | 36 | | 34 | | 34 | 16 | 16 | 32 |
| RMP030 | | | | | | | | 12 | | 12 | 2 | 5 | 7 |
| RMP032 | | | 18 | | | 18 | | 3 | | 3 | | | |
| RMP087 | | | 18 | | | 18 | | | | | 11 | 7 | 18 |
| RMP131 | | | 45 | | | 45 | | 43 | | 43 | 22 | 23 | 45 |
| RMP231 | | | 45 | | | 45 | | 36 | | 36 | 17 | 19 | 36 |
| STR045 | 121 | | | | 54 | 175 | 108 | | 72 | 180 | 103 | 72 | 175 |
| STR049 | | | | | | | | | | | 8 | 9 | 17 |
| TDR034 | | | 18 | | | 18 | 18 | | | 18 | 9 | 9 | 18 |
| TDR062 | | | 72 | | | 72 | 58 | | | 58 | 32 | 28 | 60 |
| TFL051 | | 36 | | | | 36 | 24 | | 12 | 36 | 18 | 18 | 36 |
| TFL052 | | 36 | | | | 36 | 24 | | 12 | 36 | 18 | 18 | 36 |
| TFL064 | | 36 | | | | 36 | 23 | | 12 | 35 | 18 | 18 | 36 |
| TOP001 | | | 36 | | | 36 | 34 | | | 34 | 18 | 18 | 36 |
| TOP033 | | | 36 | | | 36 | | | | | 18 | 18 | 36 |
| TOP055 | | | 18 | | | 18 | | | | | 12 | 6 | 18 |
| TOP073 | | | 108 | | 36 | 144 | 93 | | 42 | 135 | 73 | 71 | 144 |
| | | | | | | | | | | | | | |
| **TOTAL** | **211** | **1046** | **757** | **28** | **261** | **2303** | **1592** | **128** | **548** | **2268** | **1610** | **1080** | **2690** |
| | | | | | | | | | | | | | |

### 3.1.3 Pick Design

Under MSA protocols (Gee, 2006) a “Pick” represents 42 consumer samples that are served to 60 consumers with each consumer being served 7 samples and each sample being assessed by 10 consumers. The first sample served to all consumers is designated a “Link” and designed to be a mid eating quality to align the consumers at a mid point on the scales. 10 consumers each taste a common link sample so that 6 of the 42 samples tested within a pick are links. The data from these is identified and while utilised in full to assess consumer characteristics is not mixed with subsequent sample data used for prediction modelling.

The principles involved in designing picks are described in Anon, 2008 with key aspects around the use of a 6x6 Latin square to control presentational order of 6 products, each comprising 6 samples. While the products are allocated to ensure a wide expected quality range the samples within product are selected to be as uniform as possible. As every consumer is served one sample from each product (but in balanced Latin square defined order) each consumer is expected to receive a discernible quality range.

Further detail is that consumers are paired with 5 GRL, RST or COM samples halved after cooking to serve 10 consumers or, in the case of SC2, SVD, OSO and SFR each pair served from the same sample bain marie pan at the same time. Yakiniku samples are individually cooked but also duplicated within pairs who are served in different groups.

Each of the 5 servings for any sample are in five different serving orders between 2 and 7 and within a different subset of 12 consumers, ensuring that all samples are distributed across the group and serving order in addition to fully balanced presentation at the product level.

A total of 183 consumer picks were designed with a majority entirely composed of BIN samples with some combined with other product collections to ensure linkage within the AUSBlue data.

### 3.1.4 Picking & Posting

Picking relates to the sorting of samples into picks as designated by the pick designs which utilise AUSBlue programs to select a sample, allocate to a product and then produce operational files to manage and record the sorting / picking process. These processes are further described by Gee (2006) and summarised by Anon (2008). When all samples have been confirmed as ‘found’, further software routines allocate the samples to their Latin square order and to individual consumers. The software also produces files from which to print labels used on the consumer questionnaires and plates together with files to check and process the results back into AUSBlue and the sensory files. This process was conducted for all the BIN product.

The process following picking varied with the cooking method. For SC2 and SVD samples the 42 bags (samples) selected moved directly to cooking with the cubes within each bag browned and cooked for 2 hours in a broth for SC2 or cooked directly for 2 hours in the bag using a water bath for SVD prior to transfer to 1/9$^{th}$ bain marie pans for serving. Some protocol modifications were developed to manage the SVD method and enable serving of paired SC2 and SVD samples within a common pick (group of consumers).

The RST and COM samples were transferred directly to cooking once picked as no further preparation was required.

The SFR and YAK samples were further processed by slicing the prepared sample blocks into 22 Stirfry pieces, notionally 10 x 10 x 75mm or to 20 Yakiniku slices notionally 20 x 50 x 4mm prior to cooking.

The GRL picks required a standard "Posting" process in which the 5 steaks within each sample were arranged into specific order and positions on 21 vacuum packed A4 Round Sheets to control cooking and serving order. To conduct a post, the 42 sample bags were laid out on a table in alphanumeric order adjacent to a vacuum packing machine and opened. A Round Sheet with 10 EQSref and matching Sequence numbers was placed within a plastic sleeve in turn within a 250 x 350mm vac bag and secured by the closed end to a clipboard. One person was then positioned with the clipboard and called one of the 10 EQSRef numbers. A second person positioned near the 42 open sample bags then located the EQSRef and called back the Sequence number. Once confirmed the sample bag was correct by the cross calling procedure a single steak (of 5) was passed to the caller and placed on top of the EQSRef printed on the Round sheet. This process was repeated until 10 steaks were located on their EQSRef locations at which point the Round was complete and the bag vacuumed and sealed to ensure the steaks were held in position in the standard 3 – 4 – 3 orientation. The process was repeated until all 21 rounds were posted at which point all round sheets had 10 steaks and all 42 sample bags were empty.

This procedure was utilised to deliver the required presentational order. The Round sheets are laid against the grill during cooking in order from Round 1 to 7 for each group of 20 consumers within a pick. Following a timer the 10 steaks are transferred to the grill in a strict left to right, top to bottom pattern which maintains ID from raw to cooked.

# 4 Results

The result, as specified in the project objectives, was successfully achieved with the final milestone completed with the picking and posting of samples. The sensory testing and resulting data are reported within an associated project (L.EQT.1720) and have been of fundamental importance in developing the next generation MSA prediction model.

The project successfully identified and collected 26 muscles, not previously tested by MSA, together with dramatically expanding data on other muscles either not tested for a long period and/or with very low existing data. In all, 7,261 consumer samples were fabricated from up to 67 muscles, drawn from each of the 54 source cattle. Samples were prepared for paired evaluation of new cooking methods, to strengthen ageing data across muscles and to compare consumer response to selected cuts cooked on the bone relative to boneless.

# 5 Discussion

The scale and complexity of this project demanded detailed planning and extensive cooperation between multiple parties including the three BIN management groups, other research interests to be accommodated within each group, MSA staff, the abattoirs, UNE and contract staff. The need for extremely detailed muscle identification demanded highly skilled butchers, more akin to dissectionists, with the control of samples and preparation also well beyond more typical cut collection and fabrication projects.

The project could not have been successfully planned and delivered without engaging a highly experienced and motivated team over a three month period and their prioritising this work despite many other demands on their time. This dedication and commitment is appreciated.

The engagement of students, including a French graduate, is considered a benefit providing the opportunity for early career scientists and students to engage in highly complex research activity in conjunction with experienced senior researchers and industry experts. This should be of great value in building industry understanding and knowledge of experimental design and protocol delivery under challenging industry conditions.

Cooperation was excellent at all sites and the assistance of all parties is gratefully acknowledged.

# 6 Conclusions/recommendations

The project highlighted a number of challenges related to both scale and complexity. These were successfully met but relied heavily on a very experienced team from MSA and external contractors. The need for extremely detailed planning and communication with abattoir staff both before and during on plant activities was reinforced and should be noted as an essential component of any future similar project.

Some practical problems were realised which related to very large primal cuts being subdivided during packing due to carton size or programmed weight limits at the abattoir after the initial bagging. This required additional primal tickets and created challenges in “reassembling” the primal at UNE. In future, this could be reduced by either alternative packaging solutions or by cut reduction along muscle seams in a specified manner.

# 7 Key messages

Given this project related to the collection and preparation of consumer samples with results primarily to be used in MSA prediction modelling, the key messages relate to process rather than ultimate industry value, although they created a sound and critical base for ensuing research activity.

Key messages are:

- 54 cattle from 3 different BIN projects were utilised to provide a wide range of cattle types from which to collect primal cuts for MSA consumer sample fabrication. This countered the risk of individual muscle differences being confounded with specific cattle types or environments.
- 7,261 consumer samples, each to be evaluated by 10 consumers, were fabricated from up to 67 muscles collected from each carcase.
- Sample fabrication included 26 muscles not previously tested by MSA.
- Many other muscles with little existing or current data were also collected.
- Samples were prepared to enable testing of new MSA cook methods including sous-vide and moist heat (combi oven) roasting together with comparison of cooking on and off the bone with boneless shin compared to osso bucco and chuck and short rib portions cooked as a bone-in piece compared to paired boneless samples from the other carcase side.
- The extensive muscle linkage within animal provides extremely powerful data for use in prediction modelling and will be a major contributor to development of MSA models.

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