final report

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Teys Australia – Creating and sharing unrealised carcase value through the supply chain.

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Executive summary

This project was established to deliver transformational change throughout the Teys supply chain and to the greater industry via development and implementation of a comprehensive Value Based Marketing (VBM) system. The VBM system was foreseen to deliver a superior value based producer payment system with enhanced producer returns, improved revenue from increased carcase value and superior product delivered to the consumer via strong, meaningful brands underpinned by eating quality.

The project has been highly successful with significant achievement across the wide scope of interlinked Value Based Marketing components. The most significant is considered to be that the Australian beef industry now has an awareness of VBM as a principle and the contributing factors involved.

Within Teys this is supported by detailed knowledge based on extensive analysis of actual company data and modelling to evaluate alternative strategies. This modelling is integrated into branding and marketing planning and has been extensively workshopped at the individual plant level. While a VBM system is yet to be formally launched the enabling factors required are in place.

Teys suppliers now receive feedback that includes an interim ranking of yield and eating quality for all MSA cattle and work is being pursued to field test both advanced objective yield and MSA grading technologies. Success in either or both areas will add accuracy to VBM calculations which in turn are expected to drive improvement in cattle supplied for mutual benefit.

A consistent research structure is now in place to evaluate both fresh and value added product utilising MSA protocols and leveraging extensive external research capacity, notably through international and Australian collaborative arrangements. Clear opportunities have been identified to derive greater carcase value from the existing supply chain and to generate ongoing industry competitiveness through a VBM system that stimulates change by directly linking returns at all points to ultimate consumer value. This system is expected to improve communication and coordination across the Teys supply chain and to encourage open fact driven collaboration for mutual benefit.

The company is poised for change through staff engagement with research, active involvement in training and VBM driven strategic coordination throughout the supply chain from livestock genetics to the final consumer product.

Due to the all encompassing nature of the project remit it coordinated the development of and supported the implementation of a number of other PIP and MSA projects, including P.PIP.0488, P.PIP.0503, L.EQT.1813, L.EQT.1814 and P.PIP.0550. While the detailed reports of these projects are intended to be read in conjunction with this report, it is clear that the research studies within and allied to this project have resulted in significant industry wide changes, including the removal of MSA meat colour requirements and identification of retail packaging influences on consumer satisfaction (P.PIP.0488 and L.EQT.1813). The mechanisms and resulting eating quality changes through a range of value adding processes are also far better understood and supported by flavour chemistry.

It is somewhat presumptuous for a consultant reporting his own activity to also evaluate the success or failure of that work. We are confident however that the project has been successful, albeit

inevitable that the work would evolve over three years to expand on some of the original objectives while being challenged in full delivery of others. A highlight from the consultant's perspective has been the outstanding support from Teys management and staff at all levels, the strong interest shown by all in the various project activities and the friendly and valuable collaboration including expert advice provided.

The collaboration and support, together with the relationship is very much valued.

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1 Background

Prior to initiation of this project Teys Australia had conducted extensive corporate planning workshops to establish a vision for the future and to determine key activities that were needed to develop and realise that vision. The vision was extremely ambitious and recognised as providing significant cultural, strategic and operational challenges across the business. In essence the ambition was to replace a long established and highly successful low cost commodity model with a tightly consumer focussed structure that could guarantee a consumer meal experience, place a value on the experience delivered and transparently connect this to supplier payment with meaningful feedback.

This transition had already begun with the establishment of branded products and through daily relationship management with major domestic retailers but it was recognised that a considerable task lay ahead to develop the longer term strategy and coordination needed to fully implement the agreed aspirations.

This project was established to deliver transformational change throughout the Teys supply chain and to the greater industry via development and implementation of a comprehensive Value Based Marketing (VBM) system. The VBM system was foreseen to deliver a superior value based producer payment system with enhanced producer returns, improved revenue from increased carcase value and superior product delivered to the ultimate consumer via strong, meaningful brands that were underpinned by eating quality.

The simple underpinning principals were to deliver additional value to consumers generating increased revenue with true value transparently tracked through the supply chain to ascribe accurate valuation to contributing processes and the source carcase.

The project was established to assist in developing the required knowledge and analysis to enable business adoption. This required in depth analysis of historic data, liaison with Teys management, marketing and production staff, a moderate understanding of current systems and facilities including differences across the six primary production and additional value adding sites and, where appropriate, access to external independent experience and research inputs.

The project run over three years addressing three main focus areas and incorporating people capability and change management across the whole, as shown below in Figure 1.

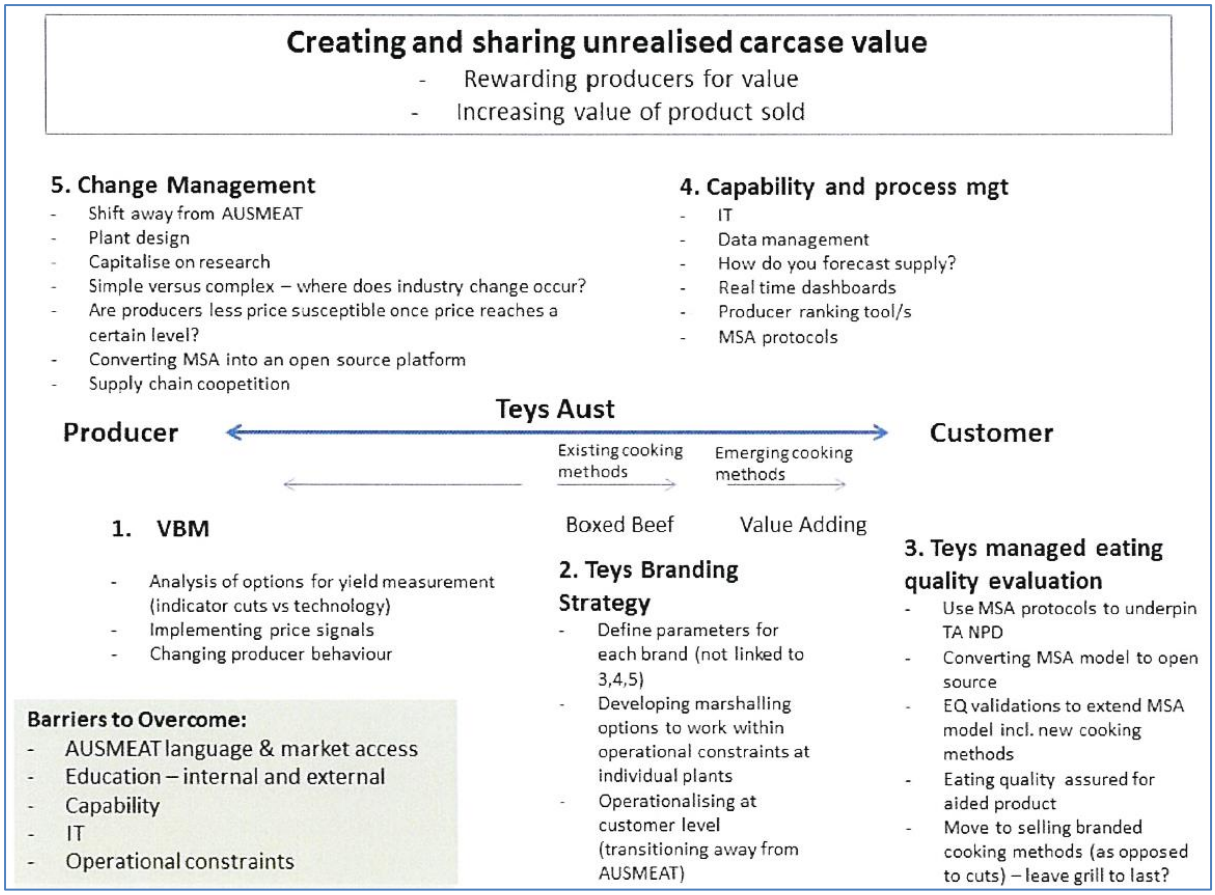

Figure 1. Strategic areas requiring development and integration to realise the Teys vision.

Focus Area 1 – Value Based Marketing:

The project contract recognised that the core principal was to accurately identify value impacts at each point of the supply chain and to directly align communication and price signals. It was recognised that all value flowed from the final consumer purchase, but also that it was dispersed and often distorted by intermediate sectors. These ranged from distribution and marketing channels to livestock supply and payment systems.

A fundamental component of the initial focus was to determine the most appropriate measurement of yield to support the VBM system. As true carcase value is the sum of the direct extension of weight by satisfaction level, and a related price, for each carcase component both yield and eating quality estimates were seen as crucial to project success. While MSA grading outputs provided a background calculation of individual cut eating quality within each carcase considerable project work was anticipated to harness this knowledge for Teys brand specifications and to develop systems that could effectively supply branded cuts within the diverse cattle populations and physical plant structures within the Teys group.

Of equal importance was producer “buy in” as without producer support VBM could not proceed. This required intensive evaluation of potential approaches to examine the distribution of value across suppliers and consignments and the flow on impact to individual returns. These findings could

dictate the timing of introducing VBM and whether a transition period was required. Critically producers needed to be engaged to understand the principals and to support and adopt VBM as a valuable driver of future industry profitability through transparent linkage of consumer value to all production steps back to livestock pricing and on farm management.

Focus Area 2 – Re-branding according to eating quality:

The contract noted that additional consumer value would be delivered via a new Teys branding strategy utilising MSA grading data at an MQ4 level (MQ4 being the Meat Quality score from 4 attributes; a numeric measure of the consumer acceptability of a piece of beef incorporating tenderness juiciness, flavour and overall liking) to accurately stream product into consistent quality levels, further supported by alternative grass and grain fed provenance positions. This represented transformational change in moving from traditional carcase category based product description to a focus on consumer assessed satisfaction and related benchmarks within market and distribution segments critically including key international markets.

Introduction of consumer focussed brands and pricing was an essential prerequisite to VBM introduction as these were the vehicle through which additional supply chain value would be monetised.

The project objectives required modelling of historic and current cattle supply across seasons and plants to determine supply challenges or constraints and to predict product volume within proposed brands including grass and grain fed streams. Modelling was required to quantify not only the distribution of each cut/muscle within MQ4 score related bands but also the efficiency with which they could be harvested by optimised carcase sorting at individual plants. The outcome was expected to influence the strategic importance of future boning room systems and cut identification. Initial challenges could impact capital expenditure requests for enhanced carcase marshalling whereas longer term implications could significantly impact boning room design and allied cut traceability technologies.

Significant implementation issues envisaged included managing the transition from AUS-MEAT category based to Teys brand based carcase marshalling (requiring a move from AUS-MEAT language, such as dentition, towards a purely eating quality based assessment) with associated implications for code and label management and transition or acceptable complementary arrangements for specific international markets or major domestic customer specifications.

A further critical strategic component was empowering the marketing transition of conventional, predominantly AUS-MEAT category based description to the new branding strategy. Company marketing and sales staff had to firstly understand and comprehensively adopt the new branding philosophy and be educated to ensure its benefits were promoted to customers. The project included an educational component to enhance understanding of the consumer based standards being implemented and the supporting science and technology. Involvement of Teys sales and marketing staff and key customer representatives in consumer evaluation studies was a key supporting activity.

Focus Area 3 – Value adding to enhance eating quality and customer value:

The project aimed to utilise existing MSA sensory testing protocols and linkage to Australian and, where available, international consumer data. Further protocol extension was planned to evaluate additional cooking alternatives with particular emphasis on those currently not within MSA but of strategic importance in target markets, China being an example. It was planned to directly test Teys branded product and potential new product offers in identified markets and distribution channels, with active engagement of Teys and customer representatives encouraged to build awareness and commitment together with optimum product targeting.

While MSA prediction was restricted to fresh product cooked by domestic appliances, the project planned to extend this to prediction of consumer outcomes when product, with that of low initial value being a priority, was further value added by potential commercial processes, with simple examples including corning or longer marinating time and longer term objectives including Ready-To-Eat (RTE) pre-cooked offers. Critical research questions to be addressed included the interaction between initial raw material standards, including MQ4 level and further processing technology.

Monitoring of associated flavour responses was regarded as fundamental to the project development activity and a collaborative arrangement under the direction of Dr Linda Farmer, a highly experienced flavour chemist from AFBI in Northern Ireland, was built into the project. From early MSA related studies it was considered that more complex flavour prediction may be possible and able to be implemented within the branding framework.

Integration with other projects:

Due to the all encompassing nature of the project it was inevitable that a number of important matters would be similar to or interact with broader industry interest and be efficiently addressed by further issue specific complementary activities. Collaborative research activity was envisaged with Australian Universities and with MSA to improve research efficiency and collaboration.

2 Project objectives

The project aimed to achieve the following objectives:

- Identify a working model for a Value Based Marketing program
- Pilot a key Value Based Marketing program with key producer groups
- Conduct the required research and development to develop an innovative branding program that is based on eating quality and consumer preference
- Conduct the required research and development to develop and innovative value adding program that improves eating quality and consumer preference
- Develop the people and systems capability within Teys and selected producers and customer to support a Value Based Marketing program

3 Methodology

A number of methodologies were utilised within the project to best deliver the required outcomes. At a high level strategic principals were discussed within one on one and group discussions with Teys management and staff throughout the business. The methodology in this area was essentially "careful listening" and discussion to better understand both the higher level strategy and the human, regulatory and physical constraints that might exist.

A highlight of the project was the development of strong relationships with company personnel at all levels that enabled a multitude of alternative ideas to be evaluated collaboratively providing the opportunity to combine extensive hands on practical knowledge of plant operations with external scientific and strategic thinking that might be adopted.

Analytical methodologies were utilised to analyse historic data and to build on that to model alternative scenarios together with potential returns. Specific cloud based Birkenwood software was utilised as a primary analysis tool after downloading company data. In particular this included daily production and MSA grading data for each plant variously evaluated on a daily, weekly, monthly or annual basis and within grain and grass fed categories. These analyses provided a base to estimate supply patterns and quantities on a muscle by grade basis.

Eating quality analysis was conducted at an MQ4 score rather than MSA grade level to enable modelling of unique Teys brand eating quality settings that reflected consumer value points and available supply. This produced a detailed MQ4 distribution for each of 40 cuts within any desired period, location or feed type. These settings were then utilised in detailed Excel based models to examine returns under a range of pricing structures. Operational implications were examined at a daily boning run level and compared to existing carcase marshalling. The data developed was then further workshopped within plant involving staff responsible for determining boning runs and marshalling carcasses and with senior experienced managers in the Brisbane head office.

Further modelling was conducted to establish a Value Based Marketing (VBM) model which combined yield and Eating Quality based branding. These models again combined extensive daily plant data over various periods and across plants with further Excel based models. Individual carcase lean meat yield was calculated by a formula provided by Murdoch University after extensive consultation and combined with 5 quality bands developed from the Eating Quality analyses. Modelling allowed variation of pricing across the developed files to measure potential scenarios.

Formal statistical methods, predominantly utilising the R statistical package, were employed to evaluate the range and distribution of carcase value within mobs and plants and to produce graphic representations to assist with industry and company presentations. The advanced statistical analyses were conducted by Dr Garth Tarr and Dr Ray Watson.

The project also included design and management of multiple research projects, some direct Teys funded PIP and others within MLA funded research that interacted with this project. Projects included Teys funded PIP relating to meat colour and retail packaging and another investigating value adding treatments and potential interactions with raw material quality. Further major research projects investigated additional retail packaging including consumer visual response, value adding of brisket and rib cuts and long term ageing of cuts from HGP treated animals. The methodology

employed in these research projects varied with the research objectives but centred on very rigorous experimental design, consumer evaluation of outcomes, detailed oversight of project implementation and expert statistical assessment by two independent statisticians. In most cases the experiments were conducted in conjunction with Australian universities and Texas Tech University.

Close collaboration with the universities was utilised as a means of building engagement with Teys staff and as a mutual tool to increase capability with plant staff gaining direct exposure to significant research trials while researchers and students gained significant insight and training in research design and execution. This collaboration led to a significant research agreement with Texas Tech University that is aimed at increasing Teys expertise together with building an environment where young graduates may consider the meat industry as a career choice. Active collaboration was also developed with a number of international research and industry organisations through personal communication and visitation. These included AFBI in Northern Ireland, resulting in commissioned flavour research, USDA MARC (Meat Animal Research Centre), with collaboration on objective quality grading and genomics, and the Irish Cattle Breeders Association (ICBF) with genomic work in addition to specialised advice on meat colour by Dr Melvin Hunt of Kansas State University and Teagasc in Ireland.

Further applied research within and in collaboration with the project has involved the evaluation and field testing of prospective objective measurement tools for yield and MSA grading inputs. The methodology employed in these projects has centred heavily on suitable trial design, data collection to strict protocols and expert statistical evaluation.

The final report on quarterly milestones for this project (P.PIP 0463) details the major activities engaged in during each quarter of the project. This report provides a high level summary of the principal issues, how they were addressed and outcomes. More detailed reporting is provided for many aspects in associated reports including P.PIP 0488, P.PIP 0503, L.EQT 1813, L.EQT 1814 and P.PIP.0550.

3.1 Focus Area 1 – Value Based Marketing

Considerable work was conducted throughout the contract period building on analysis of historic and then current data which was combined with the newly developed branding strategies and suggested settings. For milestone reporting this focus area was divided into the following components for implementation:

- Selection and implementation of a yield measurement system to support VBM
- Evaluating the options for direct versus threshold eating quality values for livestock purchasing
- Calculating the threshold carcase value
- Quantify the degree of conflict or alignment from a supplier perspective against the VBM model
- Evaluate the potential genetic and on farm technologies that impact on either direct carcase value or eating quality predictability

- Develop meaningful feedback to be communicated to producers
- Pilot and launch the value based payment (VBP) model, trialling the VBM model with 'test' producers
- Quantifying realised value difference between current carcase batch based systems and the potential return if individual cut traceability were possible

These points are discussed collectively with the observation that each has been addressed and resolved other than implementation of the producer trial. While implementation has been delayed due to the need to finalise activity in related Teys branding and objective yield measurement areas there has been far more producer exposure and discussion than envisaged. Presentations have ranged from addresses delivered to the ABARE conference, National Livestock and Genetics Consortium (NLGC) Forum, a UNECE Eating Quality Seminar in Dublin and 2017 MLA AGM to multiple producer field days and extensive publication by Beef Central and other rural media. Four formal international presentations have also been made by Birkenwood in Milan, Dublin, Stratford and Copenhagen to audiences of industry and academic representatives.

As a consequence VBM has been widely discussed throughout industry and the principals are now broadly understood by beef producers across Australia, both Teys suppliers and others. It has been heartening to observe the very strong support from producer organisations including the Cattle Council, Agforce and ALFA and at individual supplier level. This has come to differentiate Teys within the market and created a well deserved image of industry engagement and commitment to collaborative and progressive development toward a consumer focussed model. This represents a highly significant adjustment in industry culture led by a major processor of sufficient scale to stimulate whole of industry change and to lay the base for improved long term industry profitability.

As Value Based Marketing (VBM) has both yield and eating quality components work was conducted within each.

3.1.1 Selection and implementation of a yield measurement system to support VBM

No objective yield technologies were in commercial operation within Australia when the project commenced although a number were at an early research stage. UNE and Murdoch Universities had been utilising medical CT scanning for some years, predominantly on sheep carcasses, and any timely transition to beef plant application appeared unlikely. DEXA systems had been applied in New Zealand lamb plants and an Australian installation was expected but the technology was not yet extended to beef.

Australian yield indicators utilised in carcase purchase grids (HSCW, P8 fat, sex and butt shape) and reported within the AUS-MEAT language were known to be crude and highly inaccurate. USDA, JMGA (Japanese Meat Grading Association) and EUROP systems utilised more complex yield grading standards that involved calculation from measured carcase criteria and allocation to "yield grades". Each however was based on different and more uniform carcase populations than that processed through Teys plants so thought unlikely to be fully applicable. It was resolved that each should be investigated with particular attention to the EUROP system where camera based yield grades were being applied commercially in Ireland but that such evaluation shouldn't delay initial investigations. Further, it was not possible to retrospectively evaluate carcasses with these systems whereas a yield prediction equation based on existing carcase measures could be utilised across historic data.

It was resolved to utilise available yield prediction formulae for background analysis rather than delay until accurate objective technologies might be commercialised. Early evaluation of an existing yield formula supplied by Dr Alex Ball produced erratic results and new sex specific formulae supplied by Murdoch University were implemented to enable initial data analysis to gain an understanding of probable yield distributions with plants, producers and mobs based on historic and current data. The equations were:

For Steers

Predicted LMY = 62.1109 + (LeftsideHSCW x -0.09244) + (EMA x 0.1645) + (RibFat x -0.4936)

For Heifers

Predicted LMY = 59.3974 + (LeftsideHSCW x -0.09244) + (EMA x 0.1645) + (RibFat x -0.4936)

These prediction equations were developed from CT scan data from a number of trials and used to predict CT lean within an MSA database containing 4.4 million animals. Although there was no "actual" CT lean data to compare this against the predicted output was scrutinised against the training dataset to establish suggested limits of left side carcase weight between 100 and 200 kg, eye muscle area of 50 to 100 cm^2 and rib fat from 1 to 20mm. On the data available accuracy was quoted as an R^2 of 0.71 with an RMSE of 2.79. Figure 2 displays a plot of the data utilised and corresponding plots.

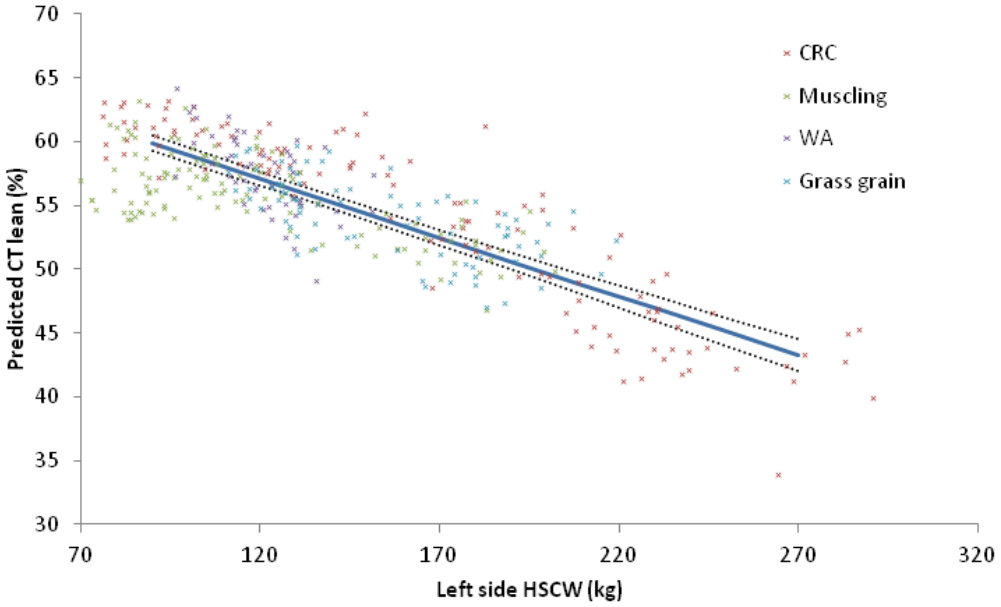

Figure 2. Predicted CT lean % in the training data sets versus left side HSCW.

An immediate issue arose from the inclusion of eye muscle area (EMA) within the formula. While EMA was measured during MSA grading it is not used within the grading prediction leading to some concerns as to measurement diligence. A further concern related to the majority of Teys plants incorporating "spencer rolling" of the cube roll prior to grading. This process allowed the longissimus muscle to be cut at the quartering point and "laid out" to enable the cut surface to be viewed for grading without cutting the backbone. This benefits the side boning chain as the carcase is less likely

to break at the quartering point and allows an MSA grade to be made. However the eye shape is distorted making accurate EMA measurement difficult.

To establish how much accuracy could be affected two TTU interns independently measured EMA at the Wagga plant for a one week period. Full quartering was conducted at this plant which does not have side chain boning. By establishing actual EMA on quartered carcasses between grader and between carcase side variance could be assessed as a bench mark and then a range of error rates modeled to investigate the related change in total carcase LMY.

On the first day each intern measured EMA on alternate carcase sides of 286 carcasses to gain an appreciation of normal variation. The correlation between the side measurements was reasonable (0.72) with standard deviations for the direct observation differences 9.51 and 7.19 for the differences between sides. The data indicate that EMA does vary within the one carcase to a moderate extent, typically within a 10 cm^2 range for at least 68% of observations. Variations of approximately 7 cm^2 were found both between sides and between graders. A “shiny app” was developed by Dr Garth Tarr to allow different combinations of HSCW, EMA and rib fat to be modeled in reference to the resulting LMY using the Murdoch formula. Figure 3 presents the side comparison of EMA.

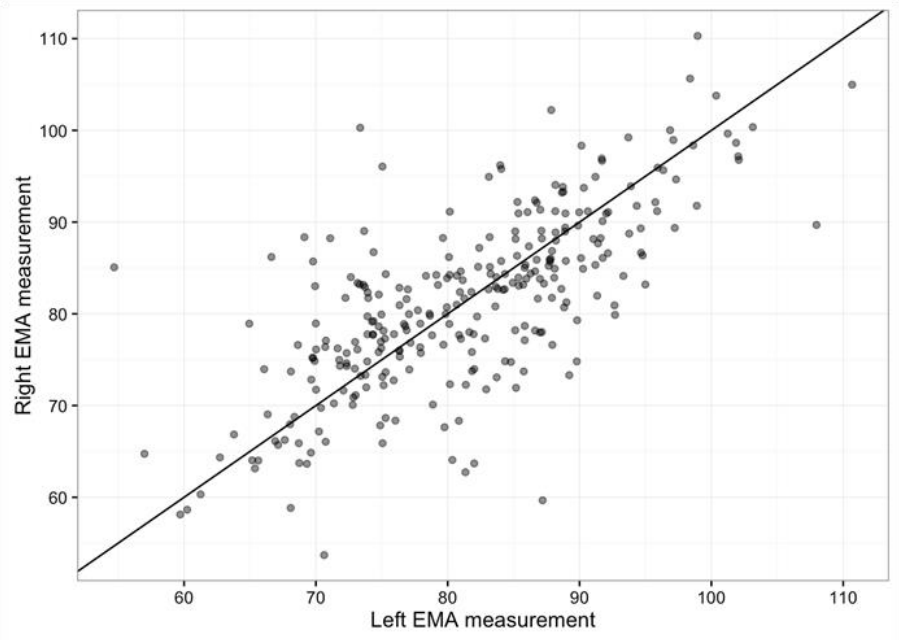

Figure 3. Comparison of measured rib eye area (REA) of left and right carcase sides.

The effective observation was that a variation in the order of 10 cm^2 for EMA measurement might be expected with a related impact on LMY estimation and extension to VBM valuation. Graphs were produced and calculations made to establish the impact of 7 and 14 cm^2 error on VBM outcomes. In general the impact was within a $0.20/kg HSCW range. More detail is included in the appendix to the 5th quarter report for P.PIP.0463.

These analyses raised two issues; the need to reduce error in EMA assessment should EMA be included in ultimate yield calculations for VBM and secondly the evident variation between carcase sides. In past work where boning tests have been conducted for yield calculations it has generally

been accepted that variation between sides was due to human error in standardising cutting lines and trim. From the carefully measured EMA data it appears that this may be a false assumption and that variation between muscles across the left and right sides does exist. This in turn suggests that accurate yield measurement may require assessment of both carcase sides rather than one.

An analysis of early data collected through yield trials at Wagga in conjunction with VIA (visual image analysis) conducted by Dr John Thompson was also referenced for comparison together with Beef CRC findings. Dr Thompson presented findings comparing accuracy of saleable meat yield predictions entirely from carcase measures (HSCW, P8 fat and sex) with chiller based measures (rib eye area and rib fat), a combination of the two utilising the VIA slaughter floor side camera (BCS) and rib eye camera (CAS) used in chiller assessment output, plus actual weight of the topside and striploin primal cuts. Figures 4 and 5 illustrate the appreciable improvement in accuracy between only carcase measurements and that obtained by also considering some actual cuts and carcase portion weights.

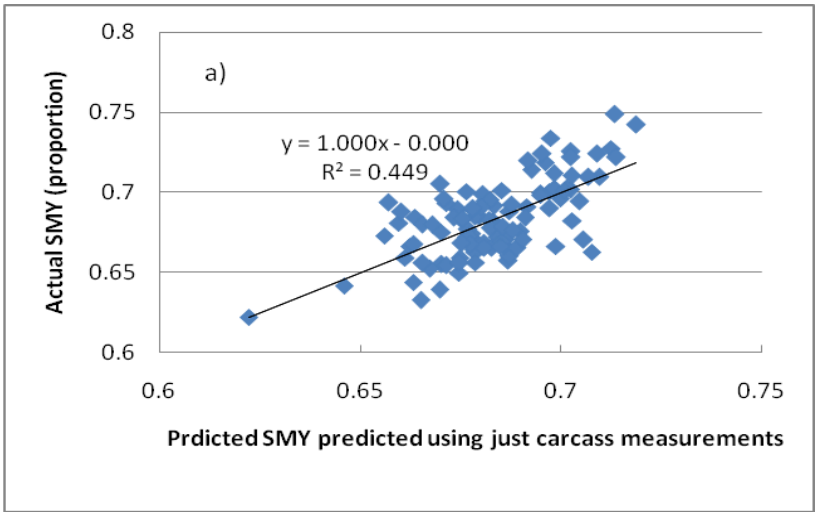

Figure 4. Predicted Saleable Meat Yield (SMY) using carcase measurements.

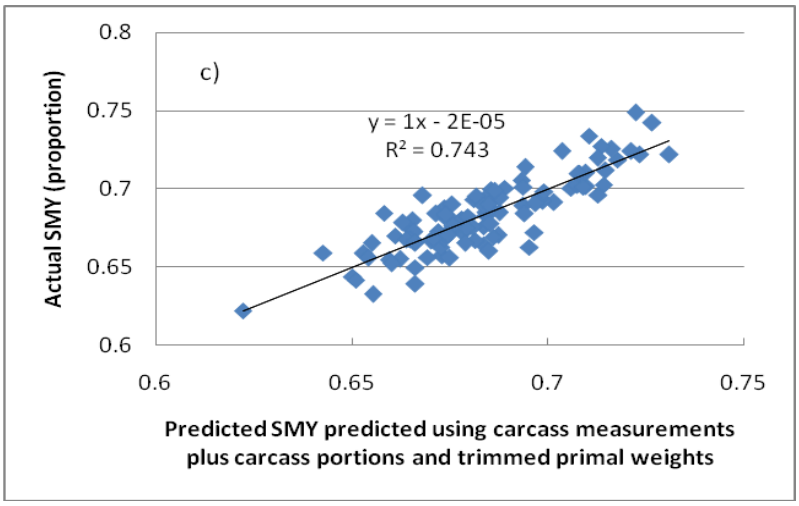

Figure 5. Predicted SMY using carcase portion and trimmed topside and striploin weights.

This approach indicated that the Murdoch formula may provide similar accuracy (R^2 of 71% vs 74.3) to a basic camera system such as the original Australian VIA although some caution should be used in comparing LMY (lean meat yield) with SMY (saleable meat yield) which includes fat normally included on retail cuts.

Further discussion was conducted within the business to assist in deciding the more appropriate measure. At first pass the notion of using actual trimmed cuts as sold (SMY) appeared the more transparent to include in a VBM structure. Further consideration however caused this to be rejected due to the extensive alternative cutting lines and trim levels associated with many commercially important cuts. For example, there were over 100 alternative specifications for each of striploin and rump within the Teys codes. If the actual codes were used in producer payment this could result in significant differences within a single shift and more across larger time periods generating confusion, and possible payment swings based on orders being processed at the precise time of boning, rather than the desired uniform and transparent structure.

Lean meat yield, equivalent to CT lean, was finally recommended as a standard as it allowed a uniform measure over all carcasses and over time providing a standard base to report yield to producers within payment systems. This election was associated with a need to have detailed conversion standards to “add back” appropriate fat and other trim to establish conversions from LMY to actual sales codes but provided the ability to apply LMY returns across all carcasses within a specific category to provide a fairer basis for supplier payment.

It was recognised that there would need to be clear communication of the price calculation routine both within the business and with suppliers. Further, yet to be finally decided, issues relate to pricing on purchase grids and feedback. In logical terms pricing might be established on a $/kg of lean meat basis but this is currently an unfamiliar term relative to the long established $/kg of HSCW measure. Whatever the final outcome producers and the business will need to clearly understand the linkage between actual cuts sold, their LMY and the source carcase.

It was recognised that the formulae and camera based comparison were less accurate than desired but provided a starting point for consistent yield reporting and feedback. It should be noted that the formula represents a considerable improvement over existing P8 fat, carcase weight, sex and butt shape measures.

E+V carcase side vision systems were observed operating in a number of Irish and Northern Irish meat factories and discussed their use with factory management and E+V executives. Dr Paul Allen of Teagasc was also consulted and provided data that he had collected during evaluation and subsequent approval to utilise the cameras commercially including for producer payment. The EUROP system utilises the letters to denote muscularity, with E or an alternative higher S score the most extreme muscling and P the poorest. A 1 to 5 fat score is attached to describe fatness to produce a base 5 x 5 grid used as a legal mandatory farm reporting standard across the European Union (EU). For research and some commercial purposes each of the letter and numeric categories may be further divided into + or – to produce a 15 x 15 point matrix.

Prior to Irish approval of the cameras, assessment had been by human graders with the cameras validated against an expert grader panel. Evaluation of these scores and farm reporting related to the carcase allocation group, U2 or O-3+ for example. While providing a general indication of yield

however the accuracy of actual cut or lean meat yield within the standard categories was variable. Similar issues existed within the USDA five scale Yield Grade system and the JMGA system which required measurement at the 5/6th rib, an inconvenient site for standard Australian boning practice.

More recent evaluation of DEXA, CT and E+V carcase side and chiller assessment image analysis systems, including pilot installation at the Rockhampton plant, are anticipated to deliver improved accuracy over time. These projects are at an early point and being progressed through the Federal Government funded ALMTech program. The Danish Meat Research Institute was also visited to discuss their experience in CT application as they have considerable research capability and a history of mechanical innovation, particularly in automated pork processing. Recent meetings at TTU and in Brisbane have discussed the potential application of CT technology adapted from airport systems that are not subject to the size, aperture shape or heating problems associated with medical systems.

A further alternative of directly weighing selected or all carcase cuts has also been explored with the MAREL group including MAREL and commercial meat factory visits in Europe and detailed IT discussion. Currently it is anticipated that this technology may be used more fully in accurately segregating branded product than directly in VBM calculation but the additional efficiency of segregation will feed back through higher returns. Depending on the technical success and commercial feasibility of CT or DEXA selected cut (those with ideally standard trim specifications) weights from MAREL output may also be utilised in yield calculation to improve the accuracy of prediction formulae.

The potential to predict carcase yield from a live animal, and perhaps more valuable, to predict yield potential at an early age, was also considered and investigated. Teys and the author met with Dr Malcom McPhee at NSW Agriculture in Armidale to discuss progress with the RGBD camera technology on live cattle and the potential utilisation for carcase measurement. Further contact was made with UTS who visited the Wagga plant to investigate the potential to use the low cost RGBD technology to assess carcasses pre or post hide removal. While showing promise the technology is yet to be made available for commercial trial but is being evaluated by others within the ALMTech program.

3.1.2 Investigation and trial of objective measurement systems for MSA grading.

A number of potential objective measurement devices were evaluated to various degrees within the project, each offering potential to replace human grader evaluation. It was anticipated that this would reduce variation in assessment and also reduce concerns regarding individual grader accuracy and consistency.

Extensive data collection was conducted throughout the project, in particular in association with product collections where cuts were to be consumer tested. Devices tested included the MIJ (Kuchida) camera, HunterLab and NIX colour devices, Caramotec (now Frontmatic) hyperspectral camera, MEQ probe and E+V rib eye grading camera.

In the early project period meat colour was identified as an urgent problem, with particular reference to Northern grass fed cattle that had high MSA failure rates due to meat colour. Initial investigation examined practices on farm, during transport and at the Rockhampton and Biloela

plants and identified a condition where meat colour of above 3 was present in many groups despite ultimate pH being below 5.7. This conflicted with the accepted norm of meat colour being a good representation of pH. Further preliminary studies and analysis of extensive plant data by Dr John Thompson provided evidence that this effect was not uncommon. Further work indicated that after cut ageing the meat colour appeared to settle to an acceptable score in line with the pH but at a point after the carcase had been rendered non MSA.

Further colour related issues were raised in the value adding plant where particular cuts regularly had an unacceptable dark colour well prior to the use by date. Dr Melvin Hunt from Kansas State University, an acknowledged global expert on meat colour and packaging interactions, was consulted and engaged to travel to Australia to visit the plants and make recommendations. He recommended changes to temperature management between slicing and retail packing, including a higher temperature to trigger muscle biochemical reactions linked to colour formation. Dr Hunts' visit was greatly appreciated by plant personnel and he delivered a series of presentations to Teys and other industry groups relating to the science and practical implications of meat colour management.

The grass fed colour issue was discussed at length with Dr Hunt during his Australian visit. He had not previously observed this issue which appeared to relate to grass fed production. It was resolved that a controlled research project that incorporated both initial pH and colour at grading and retail packaging be developed to investigate multiple colour issues and their potential interaction. The research proposal was delivered through P.PIP 0488.

This project provided a wealth of data that challenged existing practice. It collected striploin, rump and tenderloin primals from 0 to 6 tooth cattle with meat colour at grading from 1C to 5 and pH below and above 5.7. Colour measurements were made by an MSA research grader and with a HunterLab device at grading, immediately post grading on all cuts, after 5, 12 and 40 days in vacuum packs and after 9 days in overwrap (OWP), modified atmosphere 80% oxygen (MAP) and vacuum skin pack (VSP) retail packs. The packs were scored for colour appeal by untrained consumers and all samples sensory tested. The project reports contain detailed discussion with the following a brief summary:

- Meat colour of the LD grading site was found to have no relationship to the rump and tenderloin muscles immediately post boning.
- The meat colour of all 3 muscles changed post grading with the graded meat colour having no relationship to retail colour.
- The MAP packaging produced significantly lower consumer sensory scores than OWP and VSP at each ageing period (14, 21 and 49 days including 9 days in retail formats).
- Consumers rated OWP and MAP as more visually attractive than VSP but by a lesser margin than expected. By 9 days of display the VSP scores were close to MAP which declined over the display period.
- There was no consumer score difference between meat meeting the then MSA meat colour limit of AUS-MEAT 3 and higher meat colours, possibly due to the colour transition post grading.
- There was no relationship between eating quality and meat colour.

These results aroused considerable industry debate but after acceptance lead to meat colour being removed as an MSA grading criteria. This provided a substantial benefit to suppliers who were previously severely disadvantaged through failing to MSA grade.

A second extensive research trial, restricted to meat under pH 5.7 from MSA graded grain and grass fed cattle within three quality ranges was established under L.EQT.1813 which is also reported separately. This project investigated visual and sensory changes after 1, 3, 5, 7 and 9 days of retail packing in the original MAP and VSP treatments plus two additional gas mixes. The high oxygen MAP and an alternative TRIGAS treatment had substantially lower sensory ratings with the negative effect evident from one day and increasing over the 9 day period.

As a consequence, the MSA Pathways Committee recommended that an 8 MQ4 point penalty be applied to high oxygen MAP packed beef. This recommendation was supported by the MSA Taskforce and AUS-MEAT Language and Standards Committee and is to be implemented providing further consumer protection through MSA endorsed standards.

Dr Hunt also drew attention to a recently developed low cost NIX device which could measure colour simply and be suitable for retail store use. A large body of data from both packaging studies comparing untrained consumer visual scores, MSA expert grader meat colour scores, HunterLab wavelengths and NIX readings was assembled and is being statistically assessed to determine if relationships are sufficiently sound to enable a NIX reading to be used to rate retail packs during display as an industry standard.

The Kuchida camera had been used for many years prior to the project but predominantly in highly marbled Wagyu cattle. The camera is used to produce the official JMGA grading standards and is able to be used for grading in Japan. Given the extreme demands on grading accuracy in Japan (it takes a minimum 15 years for a meat grader to reach the top certification level) and the value associated with JMGA grades it was hoped this camera could be rapidly adapted to MSA grading inputs. This remains the case but progress has been slower than expected for many reasons, partly but not wholly related to the development being privately funded by Professor Kuchida who remains a full time senior professor at Obihiro University.

The original camera used extensively by the Australian Wagyu Society was a very large cumbersome device which collected data that was analysed after grading utilising image analysis. This analysis was conducted days or weeks post assessment rendering it impractical as an online tool.

Over the period of the project the camera and software has been substantially modified to a point where the latest version is being evaluated within the ALMTech program. An initial partnership with Ricoh and Professer Kuchida developed a lightweight dual camera system that did not need to be placed on the meat surface. The paired cameras utilised laser beams to locate points on the rib eye and then to correct for angle and distance prior to image analysis. This technology was already in use for order picking in warehouses. Unfortunately accuracy was insufficient at the short range needed for carcase evaluation and the device was not pursued further.

A subsequent version was produced with a single high resolution camera oriented at 30˚ to the ribeye and of a very workable size and weight. The rib eye was corrected by software to a 90˚ orientation and the image analysis routines automated to provide a 15 second response with a final

result, or alternatively a 15 second response for 100 images if loaded as a batch when leaving the chiller. This version holds great promise as a practical grading tool within the chiller. A barcode scanner was integrated with the camera to provide linkage of the image to a carcase number. The camera was battery operated requiring no cords or power supply within the chiller.

The device was trialled at Beenleigh in collaboration with the company graders. It was observed that under the very tight chiller conditions the device was sometimes difficult to place in the correct orientation due to surrounding carcasses. The problem of obtaining a clear image from a "spencer rolled" eye muscle was also noted together with the fact that the striploin face (on the upper carcase portion) presented a far better surface but was not convenient for human assessment.

A further version of the camera was then developed with a 45˚ angle to make it easier to operate in tight conditions and a revised "nose" and inverted screen to enable upward reading. The software was also demonstrated to be able to provide a return result within the claimed 15 second timeframe. This device is regarded as an excellent solution to provide MSA objective grading under standard chiller circumstances subject to AUS-MEAT accreditation. Due to a series of changes to commercial arrangements final production of MSA output rather than JMGA has been delayed several times. The camera is now officially presented as an MIJ camera with Professor Kuchida remaining the technical resource. ALMTech have included the camera in their evaluation work and a result is awaited. Early advice was that the software was excellent at high marbling levels but was less so at low marbling with some issues in dealing with reflectance from moisture on the eye and in separating connective tissue content from fat, factors in common with other cameras. A PhD study from Poland that utilised the Kuchida/MIJ camera over multiple muscles reported a high correlation between the camera, MSA and USDA expert grader scores for marbling.

The use of hyperspectral imaging has also been promoted by various international research and commercial groups for several years together with Ramon technology. Early work conducted by AFBI in Northern Ireland was discussed during meetings in Belfast. A prototype hyperspectral camera was supplied to Teys through MLA by Caromatec, a Danish company. This device was relatively cumbersome and required connection to power making it unsuitable for chiller use in its current form but with potential for use at a fixed grading station. After some initial issues several thousand images were recorded and sent to Denmark for use in calibration. No results were returned but an updated instrument version was supplied, badged as Frontmatic and included within the ALMTech program. This device was utilised at Wagga in conjunction with the MIJ camera and MEQ device (discussed below) on a major collection used to source cuts for consumer testing in several Teys and MSA research projects. No results have been advised as yet but there are unofficial reports that results appear promising.

The research hope with hyperspectral or other technologies is that they may be able to measure parameters that relate to eating quality but are not visible to the grader. This could potentially improve MQ4 prediction rather than just offer an objective tool to measure the existing traits.

A new early stage experimental device, the MEQ probe, was also utilised at Wagga. This device inserted a bank of fine needles into selected muscles and measured electrical impedance. It was claimed that, at least in theory, that the resulting data may directly relate to eating quality, to existing MSA inputs or potential new inputs. The data collected is being used for calibration at this point with a further Naracoorte trial under discussion.

The E+V camera technology in contrast is commercially deployed internationally in two forms. Within Europe a side camera version is accredited for EUROP grading which applies a carcase based muscle and fat score as discussed in Section 3.1.1. A further rib eye camera version is accredited by the USDA for USA grading. This camera evaluates rib eye area, USDA marbling, a total rib fat depth (not subcutaneous as utilised in MSA grading) and some fat and meat colour parameters. The camera is operated by a qualified USDA grader and utilised for the marbling component of USDA grading and for computation of USDA Yield Grade.

A small team viewed the E+V side camera operation at several Irish factories and met with USDA scientists who had developed the USDA software at Clay Center Nebraska. Teys have agreed to trial both camera versions in Australia with a view to employing them for yield and MSA grading inputs. Two trials, the most recent involving MSA and camera correlation over several thousand head at Wagga, have been used to collect data and calibrate to MSA settings. These data are being statistically analysed at present for presentation to AUS-MEAT. A side camera has been installed at Rockhampton in parallel with DEXA and will be calibrated from a current extensive 600 side bone out.

3.1.3 VBM System Development.

While the components can be clearly stated as a simple multiplication of kg of lean meat multiplied by a price per kg for each of the Teys branded categories the development and explanation of an active VBM system is more complex. Section 3.1.1 describes the development process to develop a measure for lean meat yield and supporting reasons for adopting LMY over SMY for payment and reporting. Section 3.1.2 addresses the preparatory and experimental work conducted to seek more objective tools to measure eating quality and yield inputs to the MSA prediction model and potential tools for objectively rating meat colour. Section 3.2 steps through a considerable body of work devoted to establishing the spread of eating quality within the current supply and the distribution of quality by muscle across locations, feed types and seasons.

These yield and eating quality strands have to be combined in a comprehensive but readily understood and transparent system for implementation. A critical component has been to benchmark potential systems against existing practice across the Teys business, suppliers, customers and by inference final consumers, typically customers of customers and substantially removed from the original cattle purchase. The justification and overall philosophy in this was that all beef industry revenue comes from the final consumer. Supporting evidence was provided through extensive willingness to pay (WTP) responses from consumers in 10 countries over 15 years. This work consistently indicated that unsatisfactory beef was valued at half good every day quality which in turn was valued at about half of premium quality with an intermediate value for better than every day.

This provided the justification to develop Eating Quality related Teys brands and to apply substantial price differentials. The consumer value strictly relates to a cooked meal performance with some further potential to leverage provenance messages over a consistent quality product.

Early project workshops with Teys marketing management established some baselines:

- Grass and grain fed product would be separately branded to align with alternative provenance positioning.
- Brands should be common across processing sites to minimise seasonal variation and ensure a year round supply.
- Common global standards were to apply to brands to provide a consistent offer in all markets.

Extensive analysis of product supply and quality is reported in section 3.2. The brand settings elected from this work were combined with individual carcase LMY estimates to evaluate VBM alternatives. A core portion of this requires estimates of the relative importance of weight (yield) and the proportions of each brand quality level supplied. Interactive models were built to enable a wide range of options to be calculated to test the relative impact.

The actual modelling used was highly detailed and was tested across very large carcase numbers for each plant and across seasons. Extensive discussion was also conducted with marketing staff to explore the potential brand pricing levels. In general there was considerable caution as to the ability to capture the proportional value differences indicated by WTP data and most modelling was conducted at conservative greatly reduced levels in the order of 10% increments across quality levels.

Data was then extracted for over 1 million head across 5 plants with each plant individually analysed across months and within grain and grass fed categories. The gross price paid for all cattle within the plant was totalled and then redistributed on the basis of estimated LMY for each carcase and its Brand based grouping and associated wholesale pricing. Consequently, a common sum of money was redistributed according to the estimated actual value of the individual carcasses. This provided an estimate of the degree of over or under payment relative to actual individual carcase value. A range of scenarios were tested with varying weightings toward yield or quality including payment entirely based on one or the other to examine the degree of change for each carcase.

A typical summary table for a group of 4,396 head is shown in Table 1.

The scenarios in the example shown are payment entirely based on LMY kg, entirely on the MSA Index value, a variable but in this case 50/50 combination of LMY and MSA index, entirely based on the Teys Brand and finally on a VBM basis that combined LMY with Teys Brand.

Table 1. Value distribution of a common $ pool comparing actual prices paid with estimated value.

	Difference in $/Kg HSCW						Difference
	LM Kg	**IDX**	**LM+IDX**	**Teys Brand**	**VBM**		**$/HD**
Min	-$1.24	-$1.60	-$1.42	-$1.80	-$1.54	Min	-$467.48
1%	-$0.78	-$0.66	-$0.56	-$0.74	-$0.84	1%	-$281.85
5%	-$0.56	-$0.42	-$0.39	-$0.51	-$0.57	5%	-$188.62
Q1	-$0.24	-$0.19	-$0.17	-$0.20	-$0.23	Q1	-$74.05
Mean	$0.02	$0.00	$0.01	-$0.01	$0.01	**Mean**	$0.00
Q3	$0.26	$0.16	$0.16	$0.25	$0.24	Q3	$78.04
95%	$0.73	$0.50	$0.50	$0.42	$0.61	95%	$184.14
99%	$1.07	$0.82	$0.76	$0.80	$0.88	99%	$262.07
Max	$3.10	$2.66	$2.88	$2.43	$2.80	Max	$620.03

As shown the value differences are substantial and indicate that the then current pricing grid provided a very poor value estimate relative to the assumed VBM pricing. When extended to producer feedback and payment the supplier pricing signals lacked clarity and were regarded as unlikely to encourage substantial change toward a more valuable product supplied to Teys as determined by ultimate consumer value response. Clearly if the VBM structure was applied immediately there would be very substantial discounts and premiums beyond current pricing grids. If the extreme 5% were ignored as potential data errors or non typical supply there was still a $1.18/kg HSCW variation within the supply ($373/head) representing a massive opportunity for improved supply efficiency.

The driving logic advanced for VBM adoption was that accurate pricing would lead to a rapid adjustment to supply as farmers analysed the feedback and pursued opportunities to increase the proportion of high value animals though adjustments to genetics and management. The dairy industry was held up as a working example with continual progress driven by clear price signals and accurate individual cow data.

Having established these substantial value differences further analysis was conducted on an individual property consignment basis. Clearly in a zero sum pricing analysis winners must be balanced by losers and it was important to see how this might play out on a vendor basis. If there were substantial vendor to vendor differences it might be advisable to progressively step toward a full VBM introduction to allow time for change and to avoid potential loss of cattle supply which of itself is a key economic driver of processing profitability. In the longer term it was hypothesised that mean producer returns would steadily increase (adjusted for market movement) as the supply quality improved and consequently increased the price paid. While livestock price would rise however improved sales returns and greater value spread across essentially static per head processing costs would also result in improved Teys profitability, a virtuous circle of continuous improvement driven by better cattle and higher value consumer product.

Individual consignment analysis was conducted by Dr John Thompson on a representative 239 mobs totalling 17,414 head with the average variation in gross grid versus VBM return +1.2% and the range from an extreme of +19% to -16.7%. The 95 percentile value was + 12.21% and the 5 percentile -9.5%.

Figure 6, prepared by Dr Garth Tarr from further actual mob data, illustrates the typical value spread within mobs with each including a wide value range.

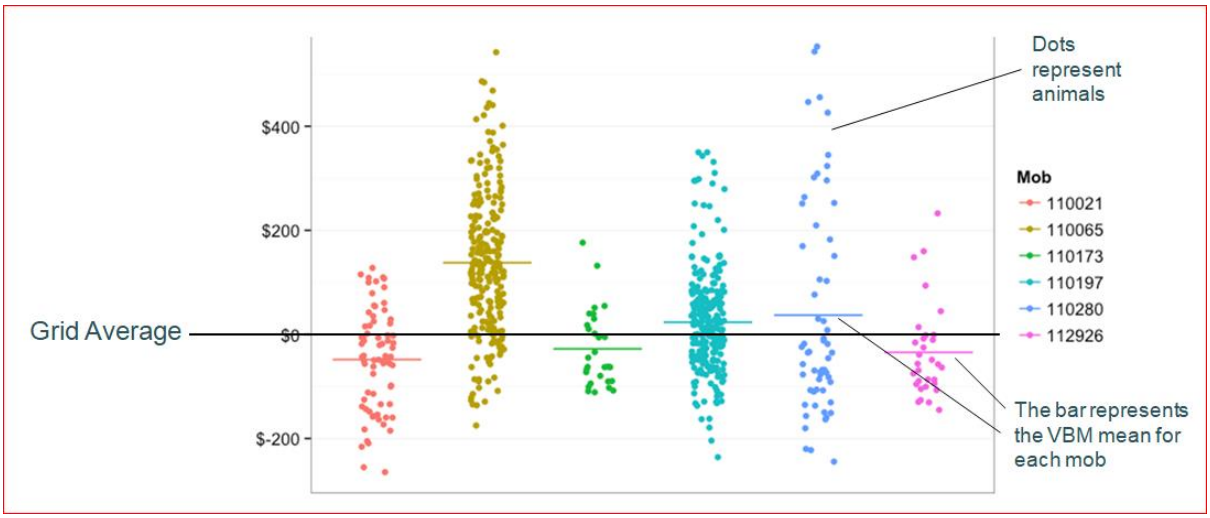

Figure 6. Individual head value differences relative to a standard pricing grid for typical mobs.

This indicated that reasonably rapid introduction of a VBM system was unlikely to dramatically affect the gross return for the majority of current consignments while delivering a very compelling price signal relative to individual animals within the mob.

Further work was progressed to develop potential VBM pricing grids and associated producer feedback in conjunction with Jessica Loughland. This entailed considerable discussion regarding the merit of pricing in LMY kg versus HSCW with appropriate adjustment. It was agreed that this required further consideration including establishing whether an LMY kg payment conformed with legal requirements as, while LMY kg reflected the actual weight of lean meat, only the carcase was weighed for individual cattle.

A further consideration related to other value contributors including processing efficiency related to carcase weight, market and brand eligibility and scope to reward volume or seasonal supply on a spot basis. These adjustments were incorporated within the VBM base framework.

A further draft producer feedback sheet was produced with the objective of providing a transparent view of all value components. The draft provided the MSA grading inputs and LMY calculation with extensions. It also included separate documentation of market eligibility payments and further adjustments to ensure that a producer could readily assess the value obtained through each component.

This in turn allowed the value of EU registration to be compared to, and isolated from, the value of improved MSA grade scores or LMY which would be of greater relevance for breeding decisions. A comparison of current grid pricing and the VBM payment for each carcase was also incorporated to provide transparency during an introductory period.

A live web based application utilising R statistics and Shiny Apps was produced by Dr Garth Tarr. This concept provided the ability for producers to log onto a Teys web site and analyse their data as

desired. Alternative sorts were enabled and graphical presentations developed to show the distribution of animals within a consignment for a range of criteria together with benchmarking and presentation of individual MSA inputs. The system was demonstrated at a head office meeting and a version provided to enable live analysis.

These concepts were discussed and an immediate intermediate step of incorporating an estimated LMY% in standard feedback adopted. In addition to the LMY% detail against each carcase a graph with axis of MSA Index and LMY% was added to feedback to acquaint producers with the VBM concept and to visualise the relationship between eating quality and yield.

Figure 7 provides an example of this presentation and also illustrates the distribution of yield within each of the proposed Teys brand categories.

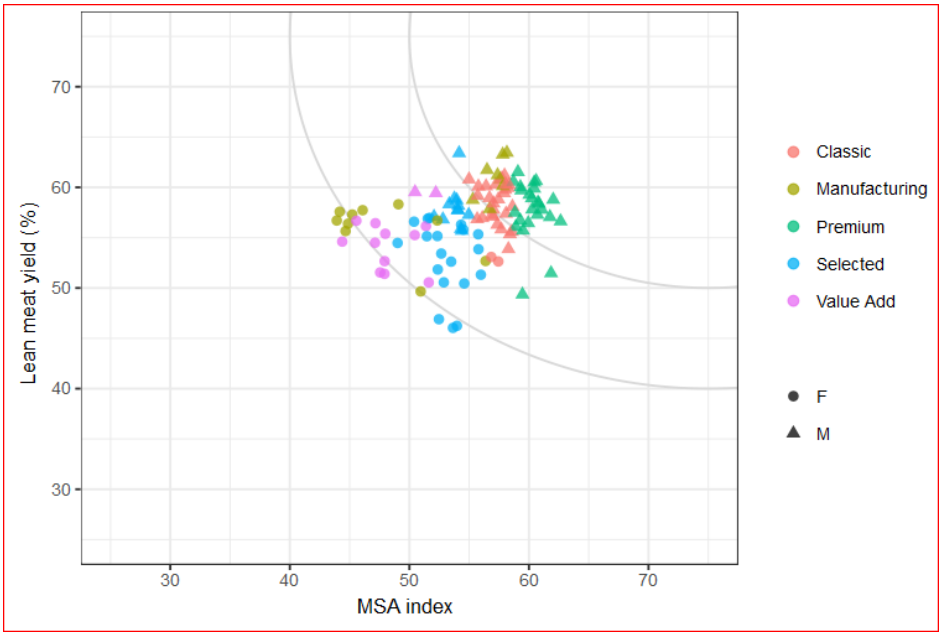

Figure 7. Graphical presentation of LMY% relative to MSA Index within Teys branding levels.

Development of the VBM concept was discussed extensively within the company including presentations to management and to livestock buyer and plant meetings. Teys have also been particularly active in presenting the concept to large audiences including at the ABARE conference and MLA 2017 AGM. Further presentations have been made at Teys producer days and extensive rural media has been generated. This has raised producer awareness of VBM and also positioned Teys as a progressive industry leader with a clear vision for total beef industry development.

It was clear that producer actions in response to accurate VBM payment and feedback would include genetic and management action to optimise results. Genetics were regarded as a critical factor due to the ultimate potential for both yield and eating quality being set at conception. It was believed that the existing Australian genetic appraisal system was heavily breed society dominated and based on a trickle down model in which purebred bull purchases provided the primary source of genetic improvement. In the majority of cases these were purchased under 2 years of age based on limited data from their growth to that point and recorded relatives. The system rarely included any progeny data due to the difficulty and cost of recording, particularly for crossbred herds. The position was emphasized by fewer than 100,000 carcase records being utilized in Breedplan from over 3 million

MSA graded carcasses per year. Teys regarded this as unsatisfactory and contemplated introducing an alternative data system for company graded cattle to increase the rate of genetic gain across the industry.

The project management team met with the Irish Cattle Breeders Federation (ICBF) in Ireland to investigate the detail of the ICBF recording system which included both beef and dairy cattle and all crosses within a single database and genomic analysis. The system was extremely impressive and thought to offer an exciting model for Australian adaption. A further meeting was held in Clay Center Nebraska with the USDA Meat Animal Research Center which has a 50 year history of genetic research and a strong focus on multibreed analysis. An aspect of their study pertinent to processing was a study of genomic association with dark cutting. An agreement was made to collaborate on this work through a Teys program at TTU reported within P.PIP.0550.

The desire for genetic disruption was shared by MLA leading to the establishment of the National Genetics Consortium (NLGC). A Vision was presented for genetic progress and VBM integration at a major NLGC forum in Brisbane. Subsequently a major NLGC project was approved to study potential genomic relationships across USDA, ICBF and Australian herds. Product from test animals will be MSA consumer tested with strong linkage to current Teys VBM project work.

MSA research projects investigating the potential to identify individual animal stress have been closely monitored with FLIR and retinal scanning systems being trialed. If successful these could offer further refinement of eating quality prediction and improve both animal welfare and consumer outcomes.

The prospect to generate a supply of high quality beef from dairy based cattle was also investigated during a meeting with Dairy Australia to discuss the economic factors that could encourage supply. Value based pricing was identified as a primary requirement to stimulate production providing price equity with beef cattle rather than an automatic discount structure. A further component for success was to ensure the final product met high level eating quality outcomes. This was uncommon under standard Australian systems but routinely achieved in Europe and Japan, and to an extent in USA, where specialised intensive feeding regimes produced well muscled and high quality carcasses of 300kg HSCW or more at 12 months of age. A collaborative project with Teys, Dairy Australia, MLA, INZAR (Spanish nutrition company), and other industry partners was developed to provide solid research backed data on what was achievable and the interaction of calf type and nutrition in determining the final product.

The project milestone to launch a pilot VBM program has not been achieved at this point despite widespread industry interest and support garnered through extensive discussion at multiple forums. Rapid development in yield measurement through current trials at Rockhampton and the timing of launching new Teys eating quality based brands has delayed implementation but both aspects are believed to offer increased value when incorporated in a program launch.

3.2 Focus Area 2 – R&D to support innovative branding strategy

For quarterly milestone reporting this focus area was divided into the objectives below:

- Analysis of MSA grading data through a revenue model to compare MQ4 scores versus boning group outcomes against branding strategies.
- Model developed to calculate alternative scenarios for harvesting and marketing options in line with the Teys branding strategy.
- Identification and prioritisation of cuts that consistently cause the carcase to fail.
- Evaluate the possibility of adoption preparation or cooking techniques that may add consumer value in alternative markets.
- Evaluate the physical facilities to meet marshalling requirements of the new branding strategy.
- Agree on pilot plant and procedures.
- Test marketing of product produced under the developed strategy in domestic and selected export markets.

Other than full test marketing of final brands each of these objectives has been met in full. The envisaged brand marketing within an associated brand map has also been delivered but a further level of sophistication, applying the strategy at MQ4 score level encompassing brand marketing of all major cuts, is scheduled to occur in conjunction with a full plant test. This has been delayed for operational reasons but remains a core objective.

The initial activity in this area proceeded on two fronts: extensive discussion with Teys marketing managers to understand and further develop a brand strategy and secondly to assess the current beef supply.

Basic analysis of numbers of head by plant and time period was expanded to a far greater depth with analysis of MQ4 score distribution of individual cuts. Base data, and aggregation into the traditional dentition based categories, was collated to provide comparison to alternatives. This included both MSA and non MSA product and subdivision of MSA product into the traditional MSA Boning Groups, again a key comparison against future models.

Full slaughter floor and MSA grade data was downloaded for all MSA eligible cattle processed at the Rockhampton, Biloela, Beenleigh, Wagga and Naracoorte plants, initially for the 2012/13 financial year and then for subsequent periods. Initial analysis was conducted on a plant basis with subdivision into grass and grain fed within month. These data were also aggregated to provide a whole of company supply position by month.

A number of marketing workshops discussed branding strategies with the overriding desire being to align brands with consumer outcomes rather than the then current AUS-MEAT cipher based description. A broad concept to use MSA MQ4 score ranges as a brand basis, presented in Figure 8, was agreed with analysis developed to quantify the distribution of product available.

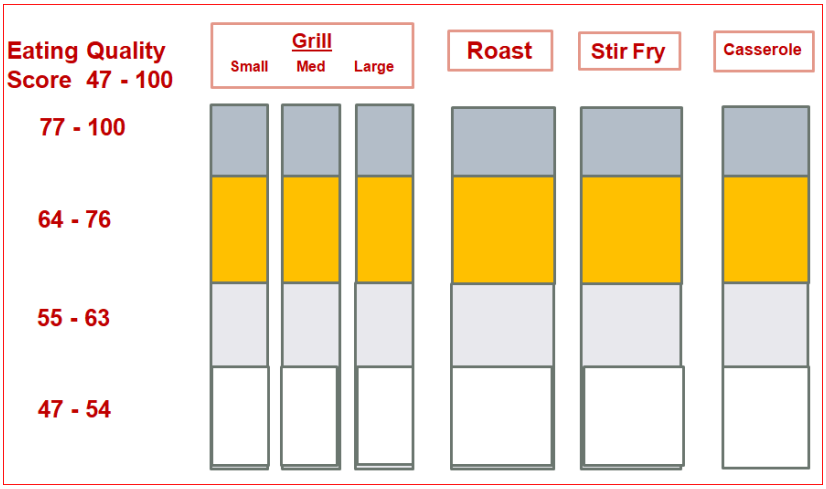

Figure 8. Initial conceptual eating quality allocation to brand categories.

Birkenwood proprietary software was utilised to conduct these analyses. A base file for each plant was provided by Teys IT staff and loaded into the Birkenwood system. Each carcase was then re-graded using the MSA model and individual MQ4 scores at 5 days ageing calculated for 40 muscles within each body. The MQ4 score is specific to both a cooking method and to the days aged. This provided the potential to optimise MQ4 outcomes by manipulating either factor on a muscle by muscle basis.

Further workshops were held with marketing personnel to consider how this could be integrated into the marketing strategy. Agreement was reached on several principles:

- That cuts/muscles should be segregated based on their best practical cooked outcome (some cooking styles such as shabu shabu were regarded as unrealistic for initial domestic marketing).
- That a base days ageing should be applied to brand specifications and varied by cut/muscle to reflect ageing potential.
- That the recommended cooking method and ageing period be the basis for the brand promise or warranty; if you do this we will guarantee a consumer outcome of that.
- As in any other goods warranty use outside this purpose was not guaranteed.
- That a common MQ4 based standard should apply across all plants to facilitate year round supply flexibility.
- That common settings should apply to grass and grain fed product.

A more disruptive option of removing cut based description and replacing it with a brand description within cooking style –"Platinum" Roast, "Silver" grill etc – was also discussed but believed to be too challenging for immediate adoption. While the logic in further simplifying consumer purchasing systems was attractive it was decided that the immediate strategy should be based on cut description with a transition over time. Early opportunities for simplification were regarded as being description of fresh stir-fry and cubed product and in RTE meal applications.

The MQ4 distribution of each muscle was collated by month and plant, grass and grain and accumulated in an Excel model. Progressive counts and % were produced for the total population

and for only those cuts meeting the MSA 3* threshold as shown in Table 2 which displays a portion of the actual layout.

Table 2. Example of MQ4 score distribution analysis.

ALL PLANTS - Jul 2013 - Jun 2014		STA045										
Base nos are GRL at 5 Days Aged		GRL @ 35 Days	45	46	47	48	49	50	51	52	53	54
GRASS	HEAD	GRL @ 5 Days	37	38	39	40	41	42	43	44	45	46
July	41689	380	534	650	807	953	1125	1253	1355	1409	1543	1668
August	41217	279	414	540	704	858	1001	1129	1283	1414	1633	1739
September	39426	247	336	447	570	692	789	850	939	1090	1353	1599
October	50169	224	310	431	504	593	739	874	1007	1090	1246	1495
November	52829	143	175	235	301	359	475	568	625	782	947	1146
December	34488	47	65	72	116	123	176	255	336	453	567	696
January	42667	93	135	164	222	258	334	389	426	520	654	769
February	45411	172	235	303	394	449	564	632	700	768	858	1034
March	37494	197	245	320	379	479	537	647	750	889	1036	1220
April	32015	220	301	414	554	634	704	795	819	956	1059	1190
May	33360	146	157	225	358	412	539	694	725	846	1008	1229
June	29575	183	262	359	410	533	657	769	877	929	992	1044
TOTAL GRASS: Jul13-Jun14	480340	2331	3169	4160	5319	6343	7640	8855	9842	11146	12896	14829
	% By MQ4 above MQ4 of 45 at agreed Cook & Days Aged											
	Grass			0.9%	1.1%	1.3%	1.6%	1.9%	2.1%	2.4%	2.7%	3.2%
	Grain			2.0%	2.0%	2.0%	2.1%	2.2%	2.4%	2.8%	3.1%	3.4%
	ALL			1.4%	1.5%	1.6%	1.8%	2.0%	2.2%	2.5%	2.9%	3.3%
	Progressive % By MQ4 above MQ4 of 45 at agreed Cook & Days Aged											
	Grass			0.9%	2.0%	3.4%	5.0%	6.9%	9.0%	11.3%	14.1%	17.2%
	Grain			2.0%	4.0%	6.0%	8.1%	10.3%	12.7%	15.5%	18.5%	21.9%
	ALL			1.4%	2.9%	4.5%	6.4%	8.4%	10.6%	13.2%	16.0%	19.3%

The upper section of Table 2 shows the conversion for ageing to 35 days versus the base 5 days for the anterior portion of the striploin. Similar adjustments were made varying the cook method and ageing days to agreed brand standards for each muscle prior to producing the distributions. The lower table portion provides the counts and % at each MQ4 and the progressive %.

These tables provided a detailed basis to estimate the available quantity at any elected MQ4 cut off and, at greater detail, volume in any given month across the business or at individual plant level. Over two years this analysis incorporated 862, 578 head with grain fed totaling 390,221 head and grass fed 472,357.

The analysis was further discussed with marketing resulting in further direction on strategy:

- That the MQ4 segregation should be selected to apportion an agreed % of product into the brands rather than adopt standard MSA grade cut-offs.
- That the scores be different for each cut muscle to provide the desired volume within brand.

These decisions required the Teys system to be able to compute an MQ4 score by muscle and then to apply a procedure to allocate carcasses to a boning run on the basis of MQ4 for all muscles of interest.

Birkenwood software was further utilised to test alternative brand based cut settings against each plant and feed category by month. Initial settings were elected from the distribution tables to represent desired % allocations to brand based categories.

The settings were refined and tested over two years of supply to achieve a recommended outcome. Where a cut had an insufficient MQ4 range above the MSA threshold to provide clear consumer

differentiation into three categories only two or, in the case of eye round and knuckle cover, one brand level were specified. This ensured that the brands would be discernibly different to justify significant pricing differences.

Every carcase was sorted on the basis of 29 individual muscle settings, all of which had to be met or exceeded for the carcase to be allocated to the brand based boning run. The 29 muscles included subsidiary muscles of common cuts including the rump (4 muscles), knuckle (4 muscles) and topside (3 muscles) although these were currently not separated during boning and slicing. The presumption was that they could be segregated in future to provide a more uniform consumer experience. If the initial settings included the sub muscles there would be minimal operational change in packing a mix of traditional primal and seamed subprimals.

The reality was that the first muscle to fail a setting resulted in the carcase dropping to a lower brand category with all other cuts, most still meeting the higher grade, also downgraded. As a consequence a poor score for intercostals or shin could result in the downgrading of the tenderloins, cube rolls and striploins. To reduce the chance of this occurring the lesser value cut settings were adjusted from the strict % basis to ensure that in virtually all cases a carcase downgrade was triggered by a failure in one of the “sweet” cuts.

These analyses identified cuts that were commonly “first to fail” with striploin predominant among the higher value cuts and eye round and knuckle cover in the secondary cuts. The striploin failure rate was heavily impacted by HGP use with potential improvement from either removing HGP or tenderstretching. The knuckle cover muscle resulted in downgrading of the knuckle eye which in general was satisfactory. Seam boning of the knuckle was suggested as a counter to this issue with the knuckle, eye round and lower quality striploins identified as primary targets for value adding as discussed in section 3.3.

Further extensive analysis was conducted to examine how the volume could be adjusted by implementing tenderstretch carcase suspension and by removing HGP implant use. This utilised the same modeling structure.

The number and weight of each cut harvested within the proposed brand structure was then calculated using a further Excel based model that allowed carcase weight and cut yield % to be modified and provided for optional calculation of any combination of base primal and sub primal. The model was built on a twelve month framework by plant with accumulation to enable total supply to be determined by month and segregated for grass and grain fed. This model base was modified to calculate the same cut output segregated by MSA Boning Group criteria to enable comparison.

A pricing function was then added to the model to enable financial outcomes to be compared. A wide range of pricing scenarios were tested and discussed with all resulting in significant improvement over the MSA boning group base.

As the MSA program moved from fixed boning groups to optimisation, a partial adoption of the Birkenwood approach, the developed cut allocations were utilised to reduce an initial MSA proposed 11 PBR (plant boning runs) to 5 aligned with the branding strategy. MSA label descriptions were also adjusted to a single nominated cooking method and days aged derived from the analysis. These

settings retained division on MSA grade settings, with the Teys proprietary MQ4 settings established within the plant Uniworks software but not activated pending a full launch of the branded strategy. The adjusted settings provided greatly improved cut harvesting relative to the original Boning Groups and also superior to the MSA PBR in addition to simplified application.

Additional work involved consideration of cut specification from major retail clients that did not wish to utilise Teys brands. A series of conversions were established to allow diversion of branded product to the retailers at equivalent specification through varying the ageing criteria.

With a base branding and pricing model indicating substantial potential for higher returns more detailed attention was placed on operational issues within the plants. Each had very different physical facilities and cattle supply. Carcase marshalling areas were of particular relevance in most plants as the space and rails available often restricted the ability to sort carcasses or to group into economic boning runs. Each plant was visited and daily operation observed to identify restraints and challenges. The desired program and potential restraints were discussed in detail with plant staff and management and workable solutions developed within agreed constraints. In many cases the solutions proposed involved integration of the kill order and initial chiller rail allocation to facilitate effective carcase sorting after grading. Figure 9 displays a typical general schematic flow for one plant.

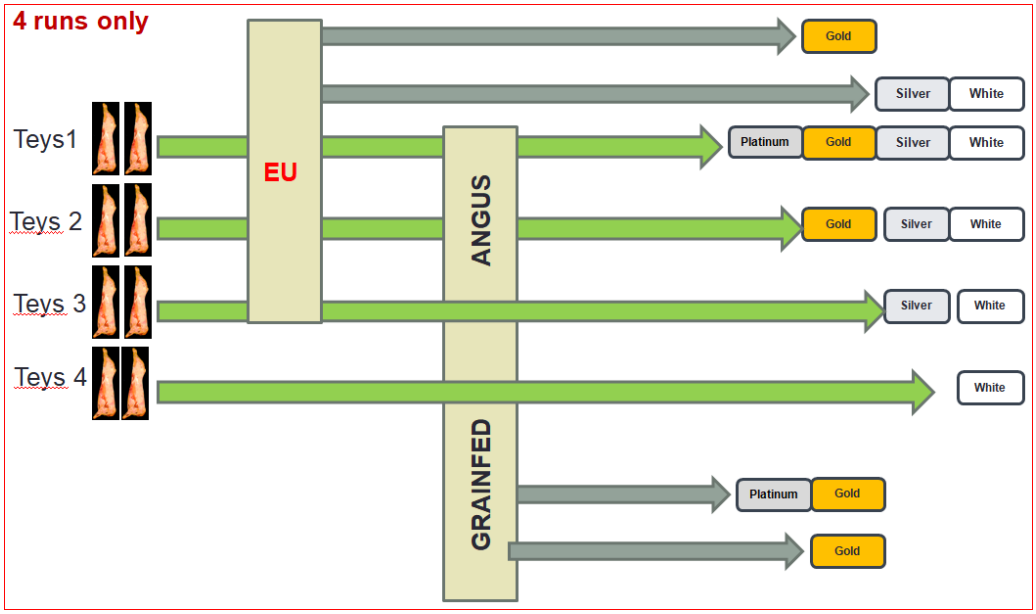

Figure 9. Conceptual product flow for one plant.

Further detail was pursued to examine operations at a daily level with each day's production analysed to compare proposed boning room runs with the current practice.

These analyses indicated a potential to achieve the desired brand based outcome with less than half the current boning runs providing a simplification of operation in conjunction with a higher value product through consumer aligned brand standards.

These outcomes were extensively discussed with operations and marketing groups to identify potential challenges in implementation. Key issues arising were:

- The added plant complexity if the old and new systems were both in operation.
- The need for extensive customer education to ensure the new brand based system was well understood and accepted as providing a superior consumer outcome.
- The speed at which a changeover could be managed.
- Potential export requirements related to existing ciphers.
- Clear representation of the relative brand offers and related acceptance of increased pricing for the premium brands.
- Culture, in the plants, in the marketing team and with customers.

The conclusion was that a commercial trial should be conducted at one plant testing full implementation of the new system. This would reduce the complexity of producing product to old and new codes and provide branded product for market development. Plans were agreed for this to take place but deferred due to a series of plant operational issues.

Assuming a commercial trial was successful it was agreed that change to the new system should be progressed over as short a period as possible. The speed of change was viewed as heavily dependent on actively working with customers to sell the benefits of the new brands. During transition existing product codes could be supplied by specific plants and the new from others but the greatest benefit was seen as achieving greater simplicity and marketing clarity through full adoption.

The approval of the EQG cipher provided simplification for most export markets allowing a common cipher across all brands. This also had significant benefit in carcase segregation allowing dentition categories to be mixed. The consultant liaised with Teys marketing to review MLA developed material to explain the EQG cipher to local and international customers. Teys took a leading role in implementing EQG in multiple markets and pressing for import agreements where required. New material has been developed by MLA to support customer understanding of the EQG cipher.

Powerpoint presentations were developed in collaboration with Teys Marketing and utilised in preliminary education of local and global customers. Branding has also been incorporated in VBM extension messages at producer and industry events. Further internal presentations have been utilised with plant and marketing groups as background tools.

It is recognised however that more intense education and training will be required to ensure that sales staff understand the new brand system and become strong and convincing advocates during the launch and subsequent roll out. This is an essential basis to achieve significant pricing differences between the brand levels and to expand differential eating quality pricing across all carcase cuts. To be effective this higher intensity training needs to be delivered close to a market launch.

The cut settings and sort procedures were further refined over the period of the project and allied with actual Teys brands developed from the initial Platinum, Gold and Silver codes. The final brand settings and price relationships were combined with the yield assumption discussed in section 3.1.1 to develop the VBM activity covered in section 3.1.2.

Further modeling work was conducted to evaluate the benefit that could accrue in cut harvesting if individual cut traceability was provided through new boning room systems. This would remove the need for aggressive carcase segregation to boning runs as cut sorting would be transferred to the packing area rather than attempted on a carcase basis. As both the grade data, and resulting grade

allocation, and the cut identification systems are electronic the two could in principle be combined to specify the correct box for packing each individual cut. This may require extension to traditional packing areas to accommodate the potential number of alternative codes.

A number of operating cut trace systems were viewed in Europe and extensive discussion held with the software engineers to define how the two software streams could be most effectively combined. Analysis indicated significantly improved revenue potential and further opportunity to allocate product to alternative storage areas or to export versus domestic customers to align optimal ageing periods with sales orders.

3.3 Focus Area 3 – R&D to support innovative value adding strategy

Significant work was conducted within this area throughout the project and is ongoing through related projects with the University of New England (L.EQT.1814) and Texas Tech University (P.PIP.0550). Two critical studies were conducted in packaging and meat colour through P.PIP.0488 and L.EQT.1813 in conjunction with Charles Sturt University (CSU) and in enhancement studies through P.PIP.0503 and P.PIP.0550. New cooking methods for beef ribs and beef brisket are being examined in L.EQT.1814. This is in addition to a series of flavour chemistry projects and consideration of work to better understand and utilise high pH dark cutting product.

Proposed project work for value adding was reported under the following headings within the quarterly milestones.

- Develop Teys managed eating quality evaluation process.
- A commercial and scientific literature review to further identify technology, equipment and processes.
- Development of new product development plan and supporting R&D.
- Three genuinely new products brought to launch each year.
- Map target consumer populations.
- Review cooking styles by market and products.
- Consumer testing protocols.
- Prediction of MQ4 results from value adding processes.

These items have not been fully met, in particular with reference to systematic mapping of consumer populations and delivery of new products directly related to the research program. Teys Australia Food Service (TAFS) have launched a large number of new products during the period but the connection between the research program and product development has not been formalised, in large part due to the timing demanded by large commercial customers relative to that required for systematic study. The program has however contributed to an improved understanding of the mechanisms underlying value adding approaches that will underpin more focussed development of genuinely new product programs. Significant advances have been made in key areas leading to identification of opportunities to increase product value through improved consumer value. This value potential arises from both increased and more consistent eating quality and through “clean label” initiatives that in combination offer a route to a premium priced product offer.

It was agreed that MSA consumer testing protocols be utilised where possible and that where new or adapted protocols were required that these be documented in detail and proposed as standards for MSA or other research use.

Initial activity was developed from documentation of cut eating quality distributions as described in 3.2.3 and the related volume of muscles that failed to meet MSA based minimum standards. Large tonnage of striploin, eye round and knuckle cuts in particular were identified as having potential to be raised to an acceptable consumer outcome through value adding processes.

Discussion with TAFS management and operational staff led to further interest in documenting value adding impact across striploin, rump and oyster blade primals that were widely used in the TAFS ready to heat or eat (RTE) meal range. A key point of interest was the degree to which the initial raw material interacted with processing to influence the final RTE outcome. The potential modes of action are summarised in Figure 10.

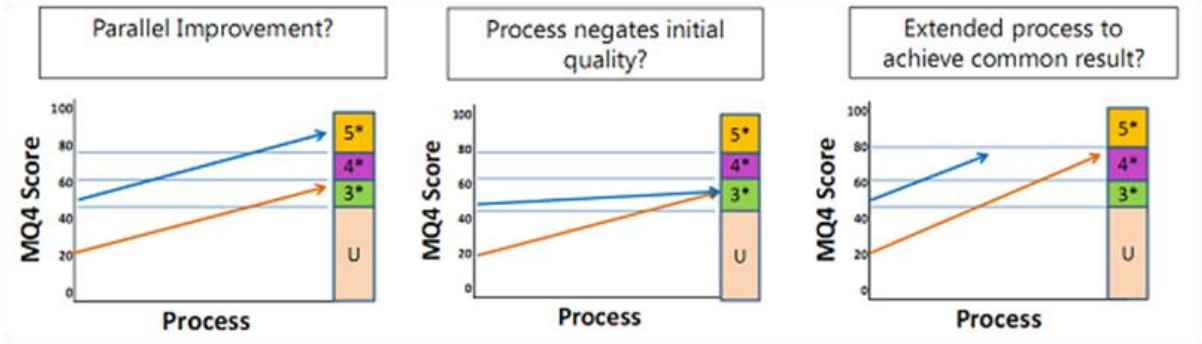

Figure 10. Possible interactions between raw material quality and process.

This fundamental question was addressed through P.PIP.0503 with the Milestone and Final reports providing more detail. In brief striploin, rump and oyster blade primals were collected from 59 carcasses representing the 5 proposed Teys brand standards within grass and grain fed product. TAFS consulted with Earlee Products in regard to alternative enhancement products and through internal evaluation elected to compare ficin, kiwifruit and conventional phosphate treatments with untreated controls. In addition the ficin and kiwi product was to be evaluated in conjunction with needle tenderisation.

The striploin and rump derived products were consumer tested as grills and roasts whereas the oyster blade was vacuum packed and slow cooked at TAFS in large industrial ovens and reheated for consumer testing to align with TAFS practice. The results were informative and encouraging. A reheat consumer testing protocol was developed and documented for utilisation in further RTE studies.

An MSA sensory testing session was held at the Teys Brisbane Head Office utilising product from the Value adding trial. Sixty personnel from TAFS Hemmant, Beenleigh and Head Office participated in the test and also received a brief overview in regard to the marketing strategy and advanced utilisation of eating quality data in brand application. This session assisted in raising awareness and understanding of the science underpinning the new Teys branding strategy and of the process being utilised to develop new TAFS products.

All treatments produced significantly higher MQ4 scores relative to control with this improvement evident in both tenderness and flavour but not in juiciness, a surprise given the moisture added during enhancement. The mechanical needle tenderizing had no effect above enhancement providing an indication that a simple enhancement process was adequate.

While all initial quality categories were improved by the enhancement treatments the degree of improvement declined as raw material quality increased.

Consumers also indicated a willingness to pay more for the enhanced products although the cut-off scores to segregate grades were somewhat higher for the enhanced product. This indicated that consumers, while enjoying the product, detected that it was “different” and required additional performance to be rated higher.

This delivered a very important marketing message that, for the products tested, enhanced meat should not be promoted as a “natural” product but rather as one that had been treated to increase performance.

Subsequent flavour chemistry analysis by AFBI again delivered unexpected results in that flavour volatiles, the smell component that mostly drives flavour perception, were not greatly increased by enhancement whereas base taste compounds, particularly sugars, were dramatically increased. This finding suggested that final cooked flavour outcomes might be adjusted by utilising precursors in pre cooking processes, a finding of potential fundamental value.

This study was followed by a further project within P.PIP.0550 and associated with L.EQT.1813 and L.EQT.1814. These projects evaluated cuts from a common product collection that utilised 90 animals systematically selected to evaluate the 5 Teys quality bands and grass and grain fed alternatives on all bar the low grass fed only manufacturing product. In this experiment striploin, cube roll, eye round and knuckle primals were utilised in the value adding enhancement project (P.PIP.0550) with initial testing at TTU.

Prior to commencing this project alternative enhancement product that might support a “clean” label were discussed extensively in Australia and USA and a literature review conducted by TTU. Further input was sought from Dr Ciara McDonnell at Teagasc in Ireland. Ciara has extensive commercial experience in the ingredients industry and is specialising in value adding research within Teagasc. Bicarbonate of soda was suggested as a “grandmas kitchen” possibility as was a mechanically modified potato starch. Consultation with an experienced traditional chef also raised the possibility of utilising a beef stock with the ability to control flavour concentration through reduction.

Each of these options was elected for trial in addition to traditional phosphate and sodium carbonate treatments, the carbonate being utilised in the USA as a phosphate replacement but having some label concerns.

The five treatments were applied and tested in conjunction with an untreated control across all cuts. The Australian quality grade mix was augmented by USDA Prime, Choice and Select grade cuts to directly link USA and Australian product. Paired Australian cuts were also retained at UNE to enable a direct USA/Australian consumer comparison. Consumer testing is currently underway in Texas with initial results showing significant eating quality improvement with the natural stock and bicarb soda

treatments, at least equal to the other alternatives. There also appear to be initial quality category related differences.

This provides encouragement for further development of a high quality “clean” label product line with the potential to utilise a natural beef stock base and to adjust this through reduction or addition of further natural ingredients including vinegar, wine, honey etc to adjust precursors and final cooked outcomes.

Two extensive packaging studies have also been completed in conjunction with P.PIP.0488 and L.EQT.1813. The first study, also discussed in brief in section 3.1.2, combined evaluation of meat colour and pH relationships across a diverse cattle range with visual and sensory consumer evaluation of product in overwrap (OWP), high oxygen (MAP) and vacuum skin (VSP) retail packaging formats. Prior to packaging tenderloin, striploin and rump muscles had been aged in vacuum packaging for 5, 12 or 40 days. Sections of each were then packed in each of the formats and displayed in a retail cabinet with consumer assessment of visual appeal.

A protocol for visual appraisal of retail packed meat by untrained consumers was developed utilising a line scale and category format similar to the sensory protocol and employing 10 consumer scores to produce a visual rating for each sample. Consumer rating of acceptable colour was found to be very consistent and unrelated to the traditional meat colour at grading standards and unaffected by carcase dentition.

A highly significant outcome was the accepted recommendation from the MSA Pathways Committee that meat colour be removed from MSA grading requirements. This removed a principal cause of grading failure in some regions adding considerably to producer returns and increasing the supply of MSA graded cuts.

After 9 days of retail display the samples were fabricated to MSA consumer test samples, frozen and sensory tested. The sensory test results indicated a significant, up to 12 MQ4 point, reduction in consumer satisfaction with MAP product relative to OWP and VSP which were similar. The detrimental effect was similar across the 3 muscles and across the ageing periods. This raised serious questions in relation to effective grading as the large volume of retail product displayed in MAP was clearly performing worse than predicted.

To answer a series of questions that arose through the initial trial a second research project was conducted and is reported in detail in L.EQT.1813. In brief the project evaluated striploin and cube roll samples drawn from southern MSA graded grass and grain fed cattle. This eliminated concerns that the earlier study may have been impacted by the older northern grass fed cattle used and by the mix of high and low pH. In this study VSP and MAP treatments were augmented by TRIGAS and high nitrogen versions of MAP. Each was evaluated visually and by sensory testing after 1, 3, 5, 7 and 9 days of retail display.

The results confirmed a negative MAP sensory impact that was evident from the first day post packing. This resulted in to a recommendation by the MSA Pathways Committee, since accepted, that all high oxygen MAP packed product should be discounted by 8 MQ4 points.

In discussion with TAFS the potential to develop higher value brisket and ribs based products was also raised noting the premium positioning of these products in Southern USA after a long slow

smoking process. To evaluate the potential briskets and ribs were collected from the 90 carcasses also utilised in the P.PIP.0550 and L.EQT.1813 projects. The Milestone reports for L.EQT.1814 provide more detail on the research design and protocol development which is being conducted in conjunction with P.PIP.0550 at TTU. Paired Australian samples are being held at UNE for direct USA and Australian consumer comparison.

In brief the study to date has utilised paired briskets drawn from each of the 9 Australian quality levels plus USDA Prime, Choice and Select grades. A detailed protocol for cooking and serving, modeled on artisan style BBQ pit cooking, has been developed and implemented.

Briskets have been cooked whole after a light salt and pepper rub and then divided into two muscles after cooking and resting for 30 minutes. Two positions within each muscle were then prepared in pulled, sliced or chopped form to enable consumer comparison of initial quality, muscle, muscle position and serving form. The samples from one brisket within each carcase were placed in vacuum sealed packaging and held chilled for one week to replicate a retail product. The paired brisket was cooked one week later and prepared in the same manner. The previous weeks vacuum packed samples were then reheated and served in the same consumer session as their freshly cooked pairs to provide an additional comparison of a restaurant style product, served directly after cooking, and the reheated pairs.

Early results have been promising with consumer scores indicating an MSA result up to high 4* quality for some product. Differences have been observed between the two muscles and between the original raw material categories.

Flavour chemistry has formed an important supporting role in these studies and is continuing to improve understanding of the mechanisms involved. Improved understanding is expected to deliver an ability to manipulate value adding processes to optimise results and increase value.

An additional issue arising from the marketing of pure grass fed only product is the degree to which flavour may differ between regions or seasons. To maintain a year round supply product may be required from Northern and Southern plants at different times. It is also thought that flavour preference may be different for consumer populations across countries with different background beef experience. It is proposed that evaluation of grass fed brands be conducted across markets to establish the degree that preference may vary and to utilise allied flavour chemistry to establish the basis for any difference in scoring.

Preparatory work has also been pursued in relation to dark cutting high pH beef which results in substantial discounting of affected product. While this problem has been discussed over many years with extension advice regarding animal management the problem has persisted and further approaches are clearly required.

The proposed work addresses two aspects: a reduction in dark cutting per se and value adding processes to better utilise dark cutting meat to reduce or eliminate the value loss.

Discussion with geneticists and meat scientists at the USDA Meat Animal Research Center indicate that there may be a genetic basis to the propensity for dark cutting. Other work conducted in Victoria by Agriculture Department dairy researchers has revealed a problem with very high protein winter pastures that creates an energy deficiency due to the conversion of excess protein. It is

hypothesized that this same condition may lead to dark cutting. Further questions to be addressed are to establish the pH relationship, and if it is consistent, between muscles and comparing dark cutting and normal carcasses.

It is recommended that these issues be systematically investigated with initial survey work to collect DNA from high pH carcasses and paired non dark cutting bodies from the same consignment followed by pH measurement of multiple muscles. A controlled study with high and low protein pasture and energy relationships and mapping of pasture conditions in regions where dark cutting is a consistent problem is also contemplated. It is then proposed that selected muscles from the paired carcasses be utilised in a range of value adding treatments to seek an appropriate treatment process. As the literature typically displays an increasing shear value to around pH 6.1 with lesser values to either side it is thought necessary to evaluate product over a range from the MSA limit of pH 5.7 to 6.5 to identify possible interactions.

Further study is recommended to investigate the potential to utilise a stock based enhancement on high pH beef to modify precursors in such a way that the meat can be successfully cooked with acceptable and predictable results.

3.4 Capacity Building – capability, process and change management

The development of a Vaue Based Payment system by its very nature incorporated the development of capability and process management both internally and with key suppliers. Due to the scale of the Teys business within the Australian cattle industry much of this work amounted to whole of industry extension to initially introduce the principle, to develop an understanding of how a VBM system could operate, and ultimately to build support. This was critical on many fronts, in the short term in addressing the risk to cattle supply and in the longer term further erosion of industry profitability if the opportunity was missed to drive efficiency gains.

Change management was identified in the project design as a critical development area throughout the supply chain and desired outcomes listed for the internal system, for suppliers and for customers as shown below.

Internal:

- Identify two people within Teys for mentoring by Rod Polkinghorne
- Development of a customised meat science course for Teys focussing on VBM
- Development of supporting materials
- Establishment of key scientific collaborative relationships

Suppliers:

- Identify key partner suppliers to pilot the program
- Develop a Teys loyalist producer advisory committee
- Producer days to educate about the new system

Customers:

- Develop educational packages
- Ensure customer needs are met through new branding strategies

These objectives have been addressed throughout the project with significant progress made in change and capacity management largely reflecting the stage of VBM development. At this point there has been outstanding success in building industry support and understanding of VBM principles. This has been driven by clear and repeated messaging by Teys through prestigious high profile events including the ABARE conference and MLA AGM and ranging down to farmer field days, Teys livestock staff contact and press reporting. There is a substantial shift in understanding relative to 3 years prior. Critically, there is strong industry support, bordering on impatience, for the launch of a VBM system.

The capacity to deliver this has been built on systematic analysis of supply data as discussed in prior sections with the analysis confirming the considerable value variation within mobs supplied and the distribution within the many mobs individually analysed.

The consultant has worked with a large number of Teys employees including mentoring of a number at a general level rather than a specific two as originally envisaged. It is believed that this aspect could be improved in future projects by formalising some key relationships and reporting, with the Strategic Livestock officers of primary importance. They have been involved to date in many projects but no regular formalised meeting structure has been followed.

Presentations by the consultant have been made at multiple levels; to senior management, to the marketing and sales team, to TAFS management, to livestock buyers meetings, to a Teys supplier day at Guyra and to management at each of the plants including reporting of individual research projects. The research projects have afforded a great opportunity to work closely with plant personnel and build communication and a better understanding of plant capability and conversely of the research process and project objectives. External communication has included presentations to a NLGC forum in Brisbane and to international seminars in Milan, Dublin, Stratford on Avon, Copenhagen (Marel MeatShowHow) and Reykjavic which have developed dialogue on VBM as a vital global industry opportunity.

Outstanding success has been achieved in the area of establishing key scientific collaborative relationships which have developed from useful contacts to highly significant collaboration including delivery of management training. The achievements noted are indicative of the level of engagement, enhanced capacity and strategic relationships developed throughout the project. Some principal scientific contacts made with the Teys group through the project include:

- Professor Melvin Hunt of Kansas State University, an acknowledged global leader in the science of meat colour and packaging, with the initial contact and discussions leading to his engagement in an Australian technical visit to troubleshoot specific plant packaging and colour problems. Professor Hunt also delivered a series of seminars on the science and chemistry of meat colour and packaging interaction at plant level and to a broad industry and research audience at the Teys head office. Subsequently he has assisted in resolving a

problem with trim processing at a major USA based hamburger client and remains in contact with Teys as a valued resource.

- Dr Linda Farmer, one of an elite group of global flavour chemists, from AFBI in Northern Ireland who has been and is currently performing contracted flavour chemistry analysis related to several Teys and TAFS research studies. Linda is leading a Teys initiative to coordinate flavour chemistry development between AFBI, TTU and CSU in Australia. A PhD student has been engaged to assist with the flavour projects which are regarded as vital to development of new value added products and to better understanding of consumer flavour response to alternative packaging and livestock sources.
  A flavour workshop was held at AFBI in Belfast to develop interaction and collaboration with attendees from TTU, Teys Australia and AFBI.
- Texas A&M University faculty but in particular Dr Russell Cross, Dr Rhonda Miller and Dr Gary Smith all of whom are highly respected meat scientists.
- Loughry College in Cookstown, Northern Ireland with the college providing practical industry training and having extensive product development capability in meat, dairy, bakery and vegetable processing including pilot plant facilities and packaging technology. These facilities and skills are of potential value in RTE meal product development.
- USDA Meat Animal Research Center (USDA MARC) in Clay Center Nebraska which is the core genetics research facility in the USA. Interaction through an initial meeting at USDA MARC has lead to research collaboration in investigating a genomic link to dark cutting propensity, to product collection to study ageing rates in HGP treated beef and to comparison of Teys and USDA grades and also to an NLGC relationship. Recent collaboration has resulted in USDA MARC scientists conducting an E+V grading camera study in the Wagga and Rockhampton plants seeking to gain AUS-MEAT accreditation for objective grading of key MSA and yield inputs.
- Teagasc, the principal Agricultural and Food research facility in the Irish Republic and in particular Dr Declan Troy, a senior meat scientist and now Director, Dr Paul Allen who was responsible for the evaluation of camera based yield grading in Ireland and Dr Ciara McDonnell who has a PhD and strong commercial background in food ingredients and value adding.
- Kansas State University with Dr Travis O'Quinn a young researcher who is very active in consumer related beef research.
- Dr Garth Tarr an outstanding young Australian statistician who has been engaged in analysis of company data, modelling of VBM scenarios, E+V camera evaluation and in delivery of a data visualisation course utilising the R package to Teys staff.
- Dr Andrew Cromie of the Irish Cattle Breeders Federation who has provided important input to the NLGC following introduction by Teys and who has also provided valuable insights into change management through his success in creating a unified genetic evaluation and herd recording structure in Ireland.
- Introduction to other leading researchers active in eating quality research including Dr Jean-Francois Hocquette, Jerzy Wierzbicki, Professor Kuchida and others.
- Texas Tech University (TTU), an outstanding USA University with a strong commercial meat science focus. Initial discussion and exposure to the TTU faculty and facilities has led to a commercial research collaboration with Teys funding matched by TTU to provide an extensive research base.

The TTU activity has resulted in TTU interns working within the Teys and TAFS business in selected project areas including value adding, camera grading and yield trials, product collection and expert industry and Teys communication and training tool development through video productions.

TTU have also developed a Teys Meat Science course structure in conjunction with Elizabeth Wilcock, key Teys staff and Rod Polkinghorne. The course has been trialled in 2017/18 utilising a Webex on line format for multiple weeks followed by an intensive 2 weeks at TTU coupled with a USA industry tour. Feedback from the participants, all identified as potential future Teys leaders, has been extremely positive.

Professors Mark Miller and Mindy Brashiers of TTU have been central to the program development and made multiple trips to Australia to establish the program and provide advise as requested. Nick Hardcastle also travelled to Australia and presented a seminar on value adding to senior TAFS staff providing an overview of typical alternative practices and the related biology.

Additional value has been delivered by interaction of Teys Australian and USA based management through visits to TTU and general collaboration which has acted to encourage collaboration and reduce barriers between academia and industry.

Further training was provided by delivery of a data analytics course to selected Teys staff including the Strategic Livestock team and IT by Dr Garth Tarr, currently a lecturer at Sydney University. The course included individual project assignments utilising company data. Delivered over two weeks, the course has provided new powerful tools through the R statistical package and associated Shiny Apps to facilitate visualisation of large data sets and management of data.

Over the course of the project substantial training has been conducted in research techniques including trial design and practical delivery to ensure integrity in sample production and identification. This has included plant staff and students from TTU, CSU, UNE and Murdoch Universities resulting in enhancement of skills and improved understanding of MSA related consumer testing processes.

4 Results

The project has been highly successful with significant achievement across the multiple interlinked Value Based Marketing components. While the detail is provided in preceding sections and related project Milestone and Final reports the central and most significant is considered to be that the Australian beef industry now has an awareness of VBM as a principle and the contributing factors involved. It has been heartening to observe the very strong support from producer organisations including the Cattle Council of Australia, Agforce and ALFA and at individual supplier level.

This has come to differentiate Teys within the market and created a well deserved image of industry engagement and commitment to collaborative and progressive development toward a consumer focussed model. This represents a highly significant adjustment in industry culture led by a major

processor of sufficient scale to stimulate whole of industry change and to lay the base for improved long term industry profitability.

Within Teys this is supported by detailed knowledge based on extensive analysis of actual company data and modelling to evaluate alternative strategies. This modelling is integrated into branding and marketing planning and has been extensively workshopped at the individual plant level. While a VBM system is yet to be formally launched the many contributing factors required are in place.

Analysis has established that typical vendor supplied mobs include a considerable value range, derived from a mix of yield and eating quality, and that these differences are not reflected in current payment systems. It is established that current systems obscure typical $300 per head / $1/kg HSCW over and underpayments in most consignments. It is contented that a transparent VBM structure would lead to a dramatic improvement in cattle supply as the strong value signals encourage change and accurate feedback identifies the means to achieve it.

Teys suppliers now receive feedback that includes an interim ranking of yield and eating quality for all MSA cattle and work is being pursued to field test both advanced yield and MSA grading objective technologies. Success in either or both areas will add accuracy to VBM calculations which in turn are expected to drive improvement in cattle supplied for mutual benefit.

A consistent research structure is now in place to evaluate both fresh and value added product utilising MSA protocols and leveraging extensive external research capacity, notably through global international and Australian collaborative arrangements. New MSA linked consumer testing protocols have been developed for the visual scoring of retail beef packaging, for testing of re-heated RTE products and for slow smoke cooking of brisket.

Clear opportunities have been identified to derive greater carcase value from the existing supply chain and to generate ongoing industry competitiveness through the VBM system stimulating change by directly linking returns at all points to ultimate consumer value. This structure is expected to improve communication and coordination across the Teys supply chain and to encourage open fact driven collaboration for mutual benefit.

Teys brands are a key driver of increased value by attaching pricing to eating quality outcomes. Data analysis within the project has been used to establish brand specifications and then further utilised to examine how they might be applied practically at plant level within existing plant structures and potential future technologies.

Brand based differentiation of value added products has also been investigated with evaluation of interactions of raw material quality with potential treatments, modified cooking styles and retail packaging. While several enhancement treatments have significantly improved consumer ratings an important conclusion has been that enhancement treatments are evaluated differently to fresh meat by consumers with a consequent recommendation that they be promoted as a different category.

The potential to modify final cooked outcomes through manipulating initial flavour precursors, while at an early stage, offers exciting potential to both improve product performance and to develop clean label product lines through adaption of a natural beef stock infusion process.

Research studies within and allied to the project have resulted in significant industry wide changes through the removal of MSA meat colour requirements and identification of retail packaging influences on consumer satisfaction. The mechanisms and resulting eating quality changes through a range of value adding processes are also far better understood and supported by flavour chemistry.

Other fundamentally important activity has examined carcase yield variation and evaluation of objective technologies for yield and eating quality prediction. Current plant based trials are expected to deliver objective capacity in the near term.

An initial structured meat science course incorporating on line modules delivered by Webex and a two week USA component at TTU and related industry tour was commenced in 2017/18 with substantial further capacity building through Australian company seminars and full involvement of company personnel in collaborative research. The linkage between Teys and international and Australian research institutions has been of benefit to all parties through building greater understanding and connection between industry and academia.

Significantly the company is poised for change through staff engagement with research, active involvement in training and VBM driven strategic coordination from livestock genetics to the final consumer product.

5 Discussion

Value Based Marketing is a challenging concept at multiple levels requiring change to long established systems across the supply chain including at the sales interface. Ultimately industry culture will dictate the rate of change. The enabling technology largely exists although it will improve over time as objective technologies further evolve to deliver more accurate estimates of both yield and eating quality. The project outcomes however represent considerable progress with the industry now embracing the concept in principle and understanding the basic issues involved.

Delivered in full VBM can revolutionise the industry and ensure its future through a direct linkage to consumer derived value. This can extend from base eating quality results to include a wide range of provenance issues but without consistent eating quality these cannot successfully stand alone.

Teys are now well positioned to lead the change with all the attendant first mover benefits and challenges. The thorough and progressive development of all facets and extensive engagement of staff and management in each area has been fundamental to launching even a pilot program. While the agreed VBM operation and related product description can offer improved operational simplicity the transition provides challenges where a mix of old and new may exist. If not managed carefully this may add to complexity and create business tensions. It is thought that a rapid change would be the most efficient at plant level but this may be tempered by the ability of marketing to successfully transition major customers within the same timeframe or to ensure export specifications are aligned in all markets. A plant by plant transition may provide a means to deliver plant efficiency while supplying product under a mix of codes.

Central to success will be effective education and training for Teys staff and, critically, very effective and positive promotion of the Teys brands. Sales staff must be equipped to convince customers that the new brands represent improved value, in particular where price points are increased for the higher quality standards. The reality is that existing product description delivers a range of eating quality within brands whereas the new system will provide tighter segregation. The existing price levels are believed to in essence represent the lowest quality experienced rather than the best. Successful implementation will increase price but also value for those customers desiring a premium product and deliver better value through a more consistent product at current pricing for those desiring entry level quality and pricing.

A mix of marketing and manufacturing adoption is also an opportunity within the value added TAFS business. The project research has clearly indicated that raw material interacts with value adding processes, including packaging systems for fresh product. It is also established that considerable improvement can be made to product of lower, and often below MSA entry level, quality. Exciting potential exists to develop premium product lines, supported by clean ingredient labelling, to complement traditional moderate quality and competitively priced offers. Further work is required to deliver a suitable product range but the enabling research including flavour evaluation has been established together with access to extensive research and pilot scale test facilities at TTU and Loughry College.

Great strides have been made in engaging an extremely competent and experienced practical business with applied meat science and enabling mechanisms through education and collaboration to combine expert knowledge with expert delivery.

There is much to do but a useful start has been made supported by project outcomes.

6 Conclusions/recommendations

The project has proved successful and assisted in developing a cultural change within the beef supply community and across the Teys operating platform. There has been outstanding collaboration between business management, staff and research personnel and a structure developed to build aggressively on this base. With the structure in place it is expected that tangible product based delivery will accelerate. The time required to implement substantial change is considerable, and easy to underestimate. This is evident in that, despite the many project successes, a pilot scale launch and review of a VBM system is yet to happen.

The principles developed through the project are regarded as sound with the following recommendations offered to encourage adoption:

1. That formal links with Teys business units through regular scheduled meetings be established to encourage timely discussion and application of research and strategic activity in product development and marketing.
2. That further capacity building for the marketing team be addressed prior to a full VBM based branding launch to provide confidence that they can move the “mountain of newly

described product" as the plants change over. While the team are already committed their short term success is a critical foundation to delivering the additional revenue envisaged.

3. That management and consulting KPIs' be coordinated to encourage a more direct and timely interaction to accelerate product development and market launch.
4. That product description be increasingly linked to a final meal result rather than a traditional cut base.
5. That both fresh and pre-cooked branded product be consumer tested in target markets to assist in introducing the brands and in tailoring standards.
6. That a study be made to track secondary cut sales through to their ultimate final use as a basis for defining quality segments and identifying premium markets.
7. That further work be conducted to fully explore the potential to utilise beef stock, adjusted by reduction and ingredient mix, as a primary enhancement aimed at adjusting flavour and tenderness precursors.
8. That coordinated research address high pH dark cutting beef including the potential to reduce dark cutting through genomics and pre slaughter feed composition together with the use of precursors to counterbalance the current problems in cooked product through precursor adjustment.
9. That young graduates within the business and identified future leaders be engaged in strategy and research activity to further develop their knowledge and analytical skills.
10. That international and Australian research collaboration be maintained and further developed.
11. That project reporting be simplified to report activity within major focus areas each period rather than through highly detailed prescribed sub headings.

7 Key messages

Key messages arising from the project are:

1. Detailed analysis supports the introduction of a Value Based Marketing model.
2. Consumer value should drive every aspect of marketing and production.
3. Consumers consistently identified multiple eating quality levels and assigned large price/value differences.
4. Three clearly defined eating quality based brand levels can be supported within current supply across the company.
5. These differences are also found within value added product ranges albeit with modified cut off MQ4 levels.
6. The long term quality mix can be influenced by accurate value based pricing signals.
7. Traditional livestock pricing systems encourage averaging and mask extreme differences within groups supplied.
8. Accurate value based pricing would produce considerable discounts and premiums within all vendor lots but these would mostly cancel each other out to result in a minor initial effect on gross return per mob.
9. Aggressive producer action in response to value based price signals has the potential to dramatically improve the overall supply through management practices.

10. Objective measurement of yield and eating quality inputs is not yet achieved but seems imminent. These technologies are expected to improve further.
11. A strong collaborative relationship between staff within the business and global scientific expertise can be of great benefit to all parties.

8 Bibliography

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