AMPC
AUSTRALIAN MEAT PROCESSOR CORPORATION

Meat Science Toward 2030

Meat Science Toward 2030: An International Forum for the Development of Strategic Objectives

Contents

1.0 Executive Summary

The Australian red meat industry remains a global leader in innovation, pioneering new technology and product marketing to a diverse range of domestic and international markets. Industry investment has delivered best in class shelf life, promising objective yield technologies and guaranteed individual cut eating quality specification. These advancements over decades have been supported by high level science and effective industry collaboration to deliver practical application.

The traditional science base has however considerably declined over the past decade or two which is also reflected globally with the downsizing or breakup of many traditionally strong meat focussed groups including the CSIRO Cannon Hill Group, MIRINZ in New Zealand, the Bristol group in England and many others including a marked reduction in the USA and in Europe. Meat science is not considered an attractive career path and the current extremely vocal anti-meat activism provides an extremely challenging environment with social and environmental issues equal in importance to the traditional human nutrition and muscle biology base. The critical need for solid multidisciplinary scientific expertise has never been greater while the traditional resource base is rapidly declining.

The project aimed to evaluate the broad issues at a global level by engaging industry, science leaders and interested parties in a broad discussion to firstly seek a consensus on the key science issues that are fundamental to industry development over the next 5 to 10 years, to provide a frank appraisal of the current knowledge and capability, and then to recommend strategies to align and encourage Meat Science activity that addresses the core imperatives.

A discussion paper was developed and circulated widely with responses sought to two core questions:

1. What are the key challenges and opportunities for meat science toward 2030 and

2. How do we harness meat science and related expertise into the future?

The paper was also published within the French peer reviewed Meat Science journal, Viandes & Produits Carnés (2018) facilitating wider circulation and discussion. Sixty-three written responses were received in addition to those from multiple discussion sessions conducted at research centres including a one-day workshop at Kansas State University and in conjunction with the ICoMST conference in Cork. Key themes and sub-themes were identified from the responses within each of the core questions and relative rankings calculated.

A detailed report was produced under Milestone 2 and both the report and raw responses circulated to an expert Meat Science group selected on the basis of scientific reputation and industry engagement. Membership was drawn from the USA (Dr. Mohammad Koohmaraie, Prof. Melvin Hunt and Prof. Russell Cross), Europe (Dr. Declan Troy, Prof. Nigel Scollan and Dr. Jean-Francois Hocquette) and Australia (Prof. John Thompson, Prof. Dave Pethick, Tom Maguire and the consultants Dr. Elizabeth Wilcock and Dr. Rod Polkinghorne).

Given COVID restrictions the planned two-day face to face workshop was not possible. This group met on multiple occasions via Zoom to discuss the report and consider how to best engage the scientific community, industry and governments in addressing the serious problems identified. An important action was to have the issues discussed in three important scientific forums: The USA Reciprocal Meat Conference (RMC) held in Reno, Nevada on August 15th 2021, The Meat Standards Australia (MSA) Pathways meeting via Zoom on August 16th 2021 and the International Congress of Meat Science and Technology (ICoMST) held in Krakow, Poland on August 24th 2021.

These forums were extremely effective with considerable interaction at each and between the events. The RMC and ICoMST meetings were major scientific events held as hybrid virtual and physical events each with a week-long program with the MSA Pathways a virtual meeting with the participants representing the principal Meat Scientists within Australian Universities and Industry.

The Pathways meeting connected by Zoom to the 2-hour RMC session on the future of meat science and immediately followed with a 2-hour discussion regarding the Australian perspective. The ICoMST program again had a 2-hour session devoted to the topic with 10 speakers with several representing the previous RMC and MSA Pathways events. The 2030 expert group were heavily engaged in all forums and instrumental in establishing each. The American Meat Science Association (AMSA), the organisers of RMC, engaged strongly offering to provide their virtual conferencing facility at no cost for a further specialised event and placing the subject on the agenda for future meetings. The ICoMST Committee also agreed to make the subject a fixed component of their annual conference.

Each event served to broaden engagement to a much wider cross disciplinary field with an important outcome being the acknowledgement that "Meat Science" could not operate in an isolated silo but should actively seek collaboration as a core component with medicine, nutrition, food science, engineering and environmental science disciplines.

There was a strong commitment from all parties to actively address the issues with a major international Summit, The Societal Role of Meat - What the Science Says, now established for October 19- 20th 2022. The Summit will be high level and invitation only with strong engagement at senior industry level in conjunction with the scientific community and governments. Participants are expected to involve themselves, not to consume the event. A working group built from the 2030 expert group, AMSA and including Professors Frederic Leroy and Peer Ederer, adding extensive knowledge of the anti-meat activist groups and the labyrinth of interconnecting associations, has developed the conference agenda.

Teagasc will host and financially support the event in Dublin with the AMSA providing a virtual interface. The Summit will address the most contentious industry issues and deliver a solid factual basis within each, to be delivered in industry and policy maker compatible form by expert communicators. The conference planning group is expanding links to other disciplines including medical, nutritional and environmental global subject matter leaders.

A further outcome has been the development of multiple resources to readily access peer reviewed science across all meat related areas and facilitate interaction across countries. The United Nations Food System Summit (UNFSS) and COP26 events also provided impetus and a sense of urgency to unifying the animal food-based industries. In Australia, the Animal Sustainable Protein Production (ASAPP) group was formed to coordinate industry engagement with the Department of Agriculture, Water and Environment (DAWE) and established an extensive SharePoint site in which over 1,000 peer reviewed papers and reports, including key anti-meat reports and published papers, was established together with short and detailed summaries. The AMSA is also seeking to build a similar assessable facility and Frederic Leroy and others have established the ALEPH website with strong interaction between all parties. Further groups have engaged with the USA Protein Pact and European Livestock Voice together with the World Farmers Organisation and extensive global networking by the Global Meat Alliance (GMA).

In an era where ideology and food politics are dominating discussion, and of most concern impacting impartial scientific publication, the need for a solid factual scientific evidence base has never been greater.

The project has successfully identified key concerns and challenges for the meat industry and for effective collaboration with the scientific community to ensure that critical global human nutrition and environmental challenges can be addressed from a factual evidence base. The problem is far from solved but there is now a consensus for action and an active global engagement that can potentially deliver mutual benefit to the meat industry, scientific community and society.

It is recommended that AMPC continue to support collaborative activity in this area including engaging the Australian industry and Government in the planned Summit and in fostering Australian structures and activity. An industry roadmap containing 12 recommendations within 3 core themes: changing the societal narrative, a new approach to teach and deliver meat science and continued expanded collaboration is presented for AMPC consideration.

2.0 Introduction

The purpose of the project was to formally assess meat science issues of critical importance to industry in both a current and medium-term period. While the meat industry had been built on fundamental and applied meat science the traditional support resources were known to be declining, in physical and human resources and, of equal concern, in community recognition and support.

The project was designed to engage at a global level and to consult with a cohort of experienced scientific leaders to identify trends, problems, opportunities and potential frameworks for future success. Industry and scientific input was to be canvassed widely and then assimilated by an expert group to identify major themes and associated issues at a more detailed level.

In addition to overall issues an important question was future capacity given the erosion in resources dedicated to fundamental research and the reduction in dedicated meat scientists due to positions not being continued with the imminent retirement of a large cohort of highly experienced and respected scientists.

Of interest was the degree to which individual country concerns and challenges were essentially universal or specific as was an understanding of alternative approaches which were seen to work either well or poorly. Finally, the project aimed to deliver insights and recommendations that could effectively address the identified challenges.

3.0 Project Objectives

The objectives of this project as specified in the research agreement were to:

◆ Develop a meat science issues paper for broad circulation across the international scientific community seeking widespread comment and solutions to current and emerging risks and challenges in the meat industry

◆ Bring together a strong collaborative international group of imminent meat scientists as the AMPC Meat Science Towards 2030: An International Forum for the Development of Strategic Objectives.

◆ Develop and deliver the AMPC Meat Science Roadmap: A frank appraisal of the current knowledge and capability, and provide recommended strategies to align and encourage Meat Science activity that addresses the core imperatives. This will include potential strategic approaches to encourage collaborative application of global resources and development of research talent together with an acceleration of knowledge transfer through enhanced industry and research interaction. This will have the imprimatur of thought leaders and experts in the international scientific community.

4.0 Methodology

The project methodology utilised a series of steps summarised as follows:

1. Production and widespread dissemination of an issues paper seeking response and discussion around two key questions:
   i. What are the key challenges and opportunities for meat science toward 2030 and,
   ii. How do we harness meat science and related expertise into the future?

The issues paper was also published within the French peer reviewed Meat Science journal, Viandes & Produits Carnés (2018) facilitating wider circulation and discussion, formally discussed as an agenda item of the MSA Pathways Committee in Australia and in a meeting at Kansas State University in the USA. The discussion paper is attached as Appendix 1.

2. Face to face and virtual discussion with a broad range of scientists, both early career and with extensive experience, commercial meat industry personnel and research funding organisations. These meetings were coordinated around several international scientific forums including ICoMST and at individual Meat Science departments or Institutes.

3. Collation of responses with key themes and sub-themes identified from the responses within each of the core questions and a relative weighting computed using the quantitative analysis methodology of Bree and Gallagher (2016). The weighting essentially reflected the number of times a specific comment or issue was noted across participants.

4. Production of a Milestone report and appendices detailing the responses and summarising the issues together with recommendations for the proposed expert group's consideration.

5. Recruitment of an expert group with international spread to consider the initial report and advance further recommended actions. The original intention for a face-to-face workshop was replaced by multiple Zoom conferences and extensive email communication in response to COVID restrictions.

6. As an outcome of (5), special purpose forums were established through the 2021 RMC conference in Reno, the MSA Pathways Committee and the ICoMST conference in Krakow to present the issues as developed by the expert group and engage with an extensive global audience.

7. These scientific forums resulted in a commitment to convene a major international Summit scheduled for October 2022 in Dublin with participation by leading scientists, industry decision makers and government policy makers. The summit is to focus on the principal contentious issues of industry concern.

8. As the project has developed, broader cross sectoral engagement has grown with the UNFSS and COP26 activities stimulating positive interactions across scientific and industry groups.

5.0 Project Outcomes

The project outcomes are briefly presented with more detailed material in the Milestone Report 2 and in the appendices.

5.1 Discussion Paper Results

Sixty-three written responses were received to the discussion paper in addition to those from multiple discussion sessions conducted at research centres including a one-day workshop at Kansas State University and in conjunction with the ICoMST conference in Cork. Key themes and sub-themes were identified from the responses within each of the core questions and relative rankings calculated.

The discussion paper proposed two core questions:

1. What are the key challenges and opportunities for meat science toward 2030 and,
2. How do we harness meat science and related expertise into the future?

Key themes and sub-themes were identified from the responses within each of the core questions and a relative weighting computed using the quantitative analysis methodology of Bree and Gallagher (2016). The weighting essentially reflected the number of times a specific comment or issue was noted across participants.

The themes, sub-themes and weightings relating to question 1 are summarised in Table 1. Five themes, Science Required, Consumer Relationships and Product Value, Supply Chain, Future Research Capacity and Value Adding were identified with multiple sub-themes within all bar Value Adding. The Science required theme had the highest overall points at 85 closely followed by Consumer relationships with 82 with supply chain at 72 and well ahead of Future Research Capacity at 18 and Value Adding at 16.

Meat and human health were the highest rated (12) within the science required theme which with consumer driven research and product development (10) indicated a strong belief that resources should be allocated close to the consumer interface. Other sub-themes of flavour, food waste, shelf life and alternative proteins also aligned with a consumer centric view. Objective measurement scored highly (12) and coupled with omics (9), big data, sensors and information management (4) suggesting that further technological solutions were foreseen together with the demands to manage the associated digital information.

Within the Consumer Relationships theme Health and Wellbeing scored the highest (22) of all sub-themes for question 1 followed by Welfare (13) and Communication (10), Sustainability (9) and Eating Quality (7). The strong ratings relating to consumer perception issues and related challenges reflected a serious concern among scientists that the debate relating to health, welfare and sustainability was a serious challenge to the industry deserving both scientific attention in providing solid scientific fact and this needing to be aligned with greatly improved industry communication.

To gain a greater insight, a number of additional sources heavily engaged in these areas were interviewed. These included traditional meat scientists, with some operating across this space such as Dr. Nigel Scollan at Queens University and others including Professor Frederic Leroy not engaged in meat science as such but expert in the communication and miscommunication agenda.

The Supply Chain theme included 6 sub-themes contributing to the 72-point weighting. Product description and information to support global trade and value-based marketing (20) and prioritizing research and investment (19) were followed by supply chain relationships (10) technical impacts on trade and regulation (9) and positioning of red meat and integrity of claims (8).

Value adding (16) was grouped as a single theme with future research capacity indicating that major issues were a skills squeeze (7) and communication and collaboration (7) followed by concerns regarding resource squeeze and achieving a multidisciplinary research approach.

Table 1. Sub themes and related weightings: "What are the key challenges and opportunities for Meat Science toward 2030?"

Order	Major Theme	Sub Theme	Weighting per Sub-Topic
		Question 1. THEMES & WEIGHTINGS	
1	CONSUMER RELATIONSHIPS & PRODUCT VALUE		
		Health & Wellbeing	22
		Animal Welfare	13
		Communication	10
		Sustainability	9
		Eating Quality	7
		Food Safety	6
		Red Meat v. Alternatives	6
		Understanding Consumers	5
		Demand	4
2	NEW SCIENCE & TECHNOLOGY REQUIRED		
		Meat & Human Health	12
		Objective Measurement	11
		Consumer driven research & product development	10
		OMICS	9
		Fundamental Biology	6
		Flavour	5
		Alternative production of Meat Proteins	4
		Animal welfare	4
		Food waste/Shelf life	4
		Big data, Sensors & Information Management	4
		Production challenges	4
		Food Security	3
		Collaboration	2
		Automation & AI	2
		Tenderness	2
		Food Safety	1
		AMR	1
		Eating Quality/ Animal Biology	1
3	SUPPLY CHAIN		
		Product description & information flow to support global trade & VBM	20
		Prioritising research & Investment	19
		Supply chain relationships	10
		Tech impacts on global trade & regulation	9
		Postioning of red meat	8
		Integrity of claims	8
4	FUTURE MEAT SCIENCE RESEARCH CAPACITY		
		Skills Squeeze	7
		Resources squeeze	2
		Communication & Collaboration	7
		Multi-discipline approach	2
5	VALUE ADDING		16

The second question, "how do we harness meat science and related expertise into the future?" generated 3 principal themes: Development of the next generation (35) Collaboration (33) and R&D required (13).

The first two in particular interacted strongly with collaboration with industry a strong focus across research groups aligned with funding structures that facilitated active collaboration between groups. Early identification of talent, industry nurturing during the education phase and experience delivered across regions and organisations were seen as critical in engaging the "brightest and best" in meat industry careers.

Investing in attracting and retaining talent (12) was the major sub-theme within collaboration followed by investment/funding arrangements (8), collaboration in development (6), curriculum (6), research relevance (2) and the role of government (1).

The engagement of students and expanding the pool by engaging early and attracting from a wider range of backgrounds supported by close industry support both through funded opportunities and clear attractive career paths were key points within the next generation sub-theme. More specifically the universal challenge of working with a declining funding base focused attention on the need to ensure training standards and active mentoring by senior faculty or industry managers to ensure delivery was possible from a reduced number of participants. The call for increased but industry targeted funding was also prominent as was the value of genuine collaboration between institutions and industry to maximise opportunity and utilisation of expertise and facilities that are spread across

diverse locations and ownership. These arrangements also needed to interact with curriculum with strong advice that meat science should be increased in standing within the science area and be seen to relate directly to other areas including nutrition and to integrate with industry experience. Enhanced supporting skills in communication, data management and statistical analysis were also noted as requirements for a successful career in the meat industry.

A telling point was "We need a grouping of senior scientists and industry to parallel that of the EAT-Lancet Commission". The need to bring together larger international teams with strong and coordinated action between education, industry, industry bodies and government to action a strong innovation agenda was a recurring view. It was also recognized that a strong strategic framework was required and this needed to be driven from a high level to integrate the many partners and ensure efficient and effective delivery across an international framework. A structure that could effectively achieve "collaboration such that funding, ideas, data etc are pooled, organized and deliver on objectives" was advocated together with an understanding of the challenges, but substantial associated global industry benefit.

The R&D required theme also interacted with many other themes and sub-themes but also brought focus to the continued need for fundamental biology and genomics work to provide the scientific base and capability to deliver a 21st century profitable industry. Again, the need to establish and communicate evidence regarding red meat in the human diet was advanced together with industry supply chain collaboration enabled by new technology to improve integration, information exchange and efficiency. The need for a strategic framework and the fundamental importance of ensuring a high-quality, safe product that provided strong consumer satisfaction and value was further emphasized – "the product must not fail".

The key sub-themes developed from the question 2 responses are summarized in Table 2.

Table 2. Sub themes and related weightings: "How do we harness meat science and related expertise into the future?"

Order	Major Theme	Sub Theme	Weighting per Sub-Topic
		Question 2. THEMES & WEIGHTINGS	
1	**COLLABORATION**		
		Collaborate	9
		Invest	7
		Establish strategic framework for research priorities and investment	5
		Leverage interdisciplinary assets	4
		Communicate	4
		Collaboration that supports skills development	3
		Establish common language	1
			33
2	**DEVELOPMENT OF THE NEXT GENERATION**		
		Investing in & retaining talent	12
		Investment Funding	8
		Collabration for development of the next generation	6
		Curriculum	2
		Establish the relevence of a) meat industry to the world &	1
		b) research ot the wider meat industry	29
3	**R&D REQUIRED**		
		Fundamental biology & genomics	4
		Evidence of health benefits of red meat	2
		Understanding the drivers of healthy meat	1
		Genomics	1
		Suppy chain integration	1
		Selection for efficiency	1
		Organic market growth	1
		R&D strategic issues	1
		Meat eating quality	1
			13

5.2 Initial conclusions from survey analysis

The conclusions below relate to the consultant's study of responses, including extensive direct discussion in conjunction with study of the written submissions reported in Milestone 2, and largely describe predominant themes while avoiding detailed recommendations of potential structural arrangements that might action recommendations.

1. A strong universal consensus exists that the Meat Industry and research community face serious threats that must be urgently addressed.

2. Threats include diminished resources in most countries and most institutions. Many previously major Meat Science and research bodies have either ceased to exist or had activity seriously curtailed over the past two decades. Not the least serious challenge is the declining ranks of expert and experienced personnel due to retirement with drastically reduced replacement numbers.

3. Also universal is the conviction that practical solutions rely on expanded local and global collaboration across industry, research and funding sources.

4. It is recognised that existing structures and funding competition most often impede large scale collaboration and that developing new approaches that encourage close across sector international collaboration is a significant challenge that must be addressed.

5. There is strong agreement that solutions require close and effective working arrangements between industry, educational and research groups over the long term with engagement of talented young people from a pre-University level and continuing in high priority managed programs that build engagement and commitment to a meat industry career. This must provide a highly skilled and empowered pool of future industry leaders with seamless links between education, research and commercial industry.

6. It is recommended that an expert group with extensive knowledge of existing structures and experienced in establishing programs be facilitated to progress proposals that could alleviate current impediments to open collaboration. Solutions may be radical and challenge existing norms but need to systematically identify the challenges and suggest means to create a new paradigm.

7. This group could arise from the International Forum and should include representation from Industry and active early career scientists who will lead future work.

8. The most appropriate forum to develop and maintain open discussion of mutual issues and coordinate response is an open question. Existing groups including the International Meat Research (3G) Foundation , UNECE Specialized Section for Meat and the International Meat Secretariat could be potential starting points.

9. Engagement across traditional sectors such as linking Meat Science research to medical, engineering, food science, statistics, computer science, communication and ethics is not entirely new but is noted by respondents as requiring more serious attention and integration.

10. The current well organised and funded activity aimed at denigrating and, in extreme groups, destroying animal agriculture is a serious threat that requires equally organised response. The basis of this response should be soundly established scientific evidence including where necessary changed practices.

11. Effective response will be best achieved by coordinated international action and require a multidisciplinary response.

It was recommended that the AMPC International Forum of selected participants be charged with addressing the concerns and priorities arising from Milestone 2 and, in particular, proposing structural arrangements that could encourage effective transition to more effective and efficient working arrangements that provided incentive for collaboration and efficient research delivery allied to commercial benefit and long-term industry sustainability.

5.3   International Forum discussion and action

The appointed forum members were selected on the basis of scientific reputation and industry engagement. Membership was drawn from the USA (Dr. Mohammad Koohmaraie, Prof. Melvin Hunt and Prof. Russell Cross), Europe (Dr. Declan Troy, Prof Nigel Scollan and Dr. Jean-Francois Hocquette) and Australia (Prof. John Thompson, Prof. Dave Pethick, Tom Maguire, and the consultants Dr. Elizabeth Wilcock and Dr. Rod Polkinghorne).

Given COVID restrictions the planned two-day face to face workshop was not possible. The raw data arising from the initial survey and the full Milestone 2 report documents and appendices were provided to the Forum members who each reviewed the data prior to an initial virtual meeting. The group met on multiple occasions via Zoom to discuss the report, review the recommendations and consider how to best engage the scientific community, industry and governments in addressing the serious problems identified.

It became evident that the initial narrower concern relating to a decline in Meat Science resources, reduction in scientific staff and consequent ability to provide industry support over the next decade needed to be considerably expanded to consider broader industry challenges that were rapidly escalating with attacks, often stemming from ideological positions unsupported by scientific data, against animal-based foods. Challenges regarding meat and nutrition and health, the environment and animal welfare were seen to pose major industry challenges and also judged to in part explain the initial problem of declining interest and resource commitment to Meat Science. While often entirely unsupported by data, opinions that animal sourced foods were bad for health, were destroying the planet and inhumane were being extensively promulgated and had created a public perception of concern and, to at least some extent, a belief that the industry was outlived, staid and declining and consequently losing funding priority and becoming an unattractive career choice for bright young professionals.

The expert group also considered that Meat Science departments and researchers had often concentrated somewhat exclusively "within the silo" and failed to engage more broadly with other disciplines despite their expert biological knowledge being closely related and fundamental to many. Put at its' simplest "Everybody Eats" making Meat Science relevant to all! The group considered that cross-disciplinary engagement with medicine, health, nutrition and environmental sciences were logical and desirable actions that could enlarge the pool of students engaging with Meat Science and gaining a broader interest in its fundamental scientific base. It was also noted that the same basic anatomical and biological knowledge complemented many engineering streams ranging from traditional engagement through refrigeration and mechanical systems to new age robotics and data management activities. Viewing Meat Science as an integral basic component of many other scientific and commercial activities was also thought to redress the staid image and increase the interest in engaging as a challenging and satisfying career option.

An important action was to work to have the issues discussed in three important forums: The USA Reciprocal Meat Conference (RMC) held in Reno on August 15th, 2021, The Meat Standards Australia (MSA) Pathways meeting on August 16th and the International Congress of Meat Science and Technology (ICoMST) held in Krakow, Poland on August 24th 2021. These forums engaged several hundred participants ranging from students to leading scientists together with industry engagement. The fortunate timing of all three being within a 14-day period enabled excellent linkage across the three engaging several hundred meat scientists, students, industry personnel and institutions across the globe.

5.4   Reciprocal Meat Conference, Reno, Nevada

The Reciprocal Meat Conference is the premier annual meat science conference held in the USA and organised by the American Meat Science Association. A special 2-hour Sunday session was established to discuss "The future of Meat Science". The session was chaired by The AMSA CEO, Collette Kaster, with speakers including forum member, Dr. Russell Cross with other high-level contributions from Dr. Keith Belk, Dr. Anne Dilder, Dr. Dean Pringle, Dr. Derris Devost-Burnett and Megan Hobbs (Cargill).

The session was well attended and extensively discussed the long history of Meat Science in the USA, developments over time and the reduction in university engagement over the past decade. The key to effective Meat Science was the relationship to consumers as a source of truth and connection to the sciences in fundamental biology, nutrition and health, animal production and welfare. Without customers there wouldn't be a meat business and without academia there wouldn't be an industry.

Research demonstrated that the problem was not the number of students being trained in meat science as much as it was the distribution of meat science programs that exist and the number of meat scientists retained in academia. It was also noted that the traditional undergraduate pool of "farm kids" with rural backgrounds was declining due to demographic changes requiring recruitment to target an entirely different audience. Many positive aspects relating to student engagement were also raised with many noting the enthusiasm engendered by aligning the science directly with the cooked meal result with Meat Science providing the "why and how". The benefit of competitive events activities such as Meat Judging and the need to engage from primary school level onwards were discussed.

An important recurring observation was that the relative salary incentives were substantially higher in industry than academia making recruitment difficult for universities. Those attracted were motivated by the satisfaction of student engagement but disenchanted by "most of their time being taken up looking for money through grant applications etc". A further frustration was the structuring of university assessment systems where promotion and recognition was driven by publication and citations with outstanding student and industry activity, arguably of greater impact and importance, unrecognised.

Megan Hobbs from Cargill conveyed a core observation about consumer society linkages and that maybe Meat Science needed to broaden its messaging to "Everybody Loves to Eat", rather than muscle chemistry which sounded a lot less interesting. Several speakers spoke of the engagement delivered by communicating "around the grill" where the meat science ABC or Anatomy, Biology and Chemistry was made relevant as a cooked meal experience.

A further positive outcome was a commitment of the AMSA to make discussion of the issue a standard component of the RMC program at future meetings. The offer was also conveyed to the expert group that AMSA would make their virtual conferencing facility available at no charge for a follow-up conference if desired with AMSA keen to be involved in this and related activity.

The entire session can be viewed using the link below:
https://meatscience.confex.com/amsa/RMC21/videogateway.cgi/id/1282?recordingid=1282

5.5   MSA Pathways Committee discussion

The MSA Pathways Committee viewed the RMC special session immediately prior to opening the Pathways meeting providing an excellent base from which to consider the Australian position and experience. The Pathways meeting was also used to formulate the Australian perspective to be presented at a special session at ICoMST on the "The future role of meat science in underpinning a global sustainable meat sector for benefit to society while accelerating innovation – A Call to Action".

The MSA Pathways Committee is a long standing (25 years) committee charged with the scientific development and oversight of the MSA program. Membership includes most principal Australian meat scientists drawn from Murdoch, Melbourne, Sydney, Charles Sturt, New England and Queensland Universities together with private researchers and MSA managers. Members range from early to late career researchers with committee tenure ranging from 1 to 25 years. As such it offered an excellent base from which to evaluate the local Meat Science scene in both an historical and current perspective. It was agreed that Australia was in an interesting position, with no formal meat science facility like Cannon Hill anymore, and meat science as a topic within courses and programs at universities rather than as standalone programs. There was less fundamental meat science being taught but a lot more active engagement at a university level.

It was noted that the aim was to come up with a simple consensus out of ICoMST, that there was a problem and emphasise the need to get an act together to consolidate at an international level by:

◆ Handling Neigh Sayers
◆ Highlighting the positives and where we are heading in the future.

The committee then addressed the subject through the framework of what were believed to be the core questions? What was the 10–20-year view, Where did we sit? What were the challenges? What did we have to address? If the Pathways Committee could come to an agreed position on these questions, then a plan could be devised to address the problems.

Several issues were identified by members and discussed in depth:

1. **Shrinking number of academics** across not only meat science but agriculture, leading to smaller teams within the universities. It was stated that the only academics that could succeed were those that had a breadth of traits (communication, good science and good teams). Individuals that didn't interact well with industry were failing despite excellent core scientific expertise as there were no longer large teams with a balance of pure and industry based applied scientific expertise coupled with communication skills. There was a need to have a big pie and split it several ways, ensuring grassroots research and enabling others to communicate with industry and deal with industry questions when needed. It was agreed that if funding was only directed to immediate applied industry programs and those with good industry communication skills the required background core science would quickly deteriorate placing future adaption at risk.

2. **Recruiting students to Meat Science** (particularly Honours, Masters and PhD). It was observed that COVID would impact student numbers coming through with delays in graduating and a 2-year gap in international students. Domestic students were needed to fill this gap or there would be significant long-term impacts. It was suggested that we should look at high school programs and more innovative ways to showcase meat science and the potential opportunities. It was also stated that to attract young people, they needed to be engaged in something of societal value. The disinformation about cattle, climate and health suggested the industry was disappearing and was damaging to the environment and people. Work was urgently needed in the advocacy space to change the view of livestock in regards to attracting students and repositioning the industry. Retaining students was also raised as a point of concern since the scrapping of CRC's. It was stated one way to deal with this could be to ensure extension and outreach plans were embedded into MLA research projects. This placed a focus on the issue that problems would develop if training of PhD or Masters students reduced, particularly in the current environment where large CRC and

bigger programs which had normally provided the funding base to develop early career scientists were finishing.

3. **Refocusing of Meat Science as a core part of related disciplines.** The position of Meat Science within a broader science framework was canvassed raising the question of whether a refocus to being a core part of many other disciplines rather than operating as a stand-alone meat science department was a sensible proposition. Could an effective approach be to link everyone through food? It was agreed that the discussion encompassed key issues with an urgent need to ensure traditional meat science was seen as a core resource for many animal and food related disciplines.

4. **Collaboration across institutions.** It was noted that Australia had an excellent record in working within multi-teams and locations, in part an outcome of declining resources and the CRC model which rewarded collaboration. MSA was a good example of Australia working collaboratively and had been hugely beneficial for 25 years. Collaboration in effect could create a more effective "large team" assembled across institutions providing funding arrangements were compatible in encouraging collaboration rather than competition between institutions.

5. **Disincentive for industry research.** If not deemed category 1 universities often applied a 20-30% overheads charge on top of project costs, making industry less inclined to use the universities as a place to do research. A new funding model was needed at universities, dispersing overheads across the categories. Industry grants were typically smaller $20,000 - $200,000 but required exactly the same amount of admin, legal contracting regardless of cost. There were some systemic problems related to getting small projects through. It was noted that universities valued research on 2 things:
   i. Citation index (high citation can charge more for student fees). Meat Science was not associated with really high citations
   ii. Funding from government category 1

   It was agreed that a unified position was critical to advocate to government regarding the value and impact of transactional research, rather than citation linked research. It was also agreed that industry bodies needed to put more pressure on the universities and Government to review valuation of research outcomes with effective industry engagement valued equally to current category 1 metrics. This position was found to be equally applicable internationally.

6. **Reductions in State and Federal Government Funding.** Australian State governments had moved out of the Meat Science space having implications for personnel but also resources, such as flocks and pilot plants. With universities losing more academic staff and state government resources being reduced, how much research would have to be industry funded? External pressure on universities was needed and funding bodies needed to ensure contracts were competitive to avoid the overhead costs. It was stated that in the NSW DPI Meat Science, particularly the fundamentals of meat science, was still seen as a focus area because it was a valuable add on to other research (soil, production and genetics). However, overheads had

now become a problem at DPI as well and they had a new costing model with budgets further pressured by COVID. Value was seen in collaborating with universities and other R&D providers where feasible to help with resourcing and building up teams.

7. **Pure vs. applied research.** Achieving an effective balance between pure and applied research was canvassed. Applied was easier to "sell" to industry due to its' front-end application and quick return but often at the cost of fundamental research which could have long term consequences. It was noted that previously cross subsidised projects had more fundamental science around the edges with bigger applied projects. The MLA view was that it was important to embed research into programs, but also agreed that there was not much pure research being funded. It was stated that there was still room for pure research but MLA, being industry funded, tended to focus more on commercial outcomes. The best opportunity to provide for early-stage research and students would be to have discovery research running alongside commercial or adoption work within a project. It was asked if MLA was being leveraged into pure research funding by reduced government funding at state and federal level given that traditionally universities were funded to do pure research. Should AMPC and MLA be requested to increase pure research, often by definition having no defined commercial endpoint, or was it more appropriate to work on the political front regarding interaction with government to emphasise the need for and value of fundamental science? It was suggested that a model that was balanced across the interests of different bodies (AMPC, MLA, University, CRC, CSIRO State and Federal Government) that accounted for all party's performance metrics should be pursued.

8. **Intimidation of scientific discussion and publication.** The growing politicisation of research and publication was identified as a serious problem and appeared to be getting worse with ideological viewpoints and activist agendas now evident in publications such as The Lancet and from high profile institutions including the Harvard Medical School, with prominent examples including Willet et.al. (2019) and the Global Burden of Disease (2020). Highly qualified and respected researchers who had stood up against ideological views such as those relating to health and nutrition, notably in publishing papers relating to positive health and nutrition outcomes related to meat consumption, had been attacked and their careers threatened (Rubin, 2020 and Flegal, 2021) with more detailed analysis relating to the misinformation and politics relating to animal fats the subject of the book, Big Fat Surprise (Teicholz, 2014). There appeared to be a very damaging and consistent theme in the area of nutrition and health reflecting vegetarian, vegan and animal rights ideology and extensive opinionated misinformation. Recently a detailed rebuttal to the Lancet's GBD report (Lancet GBD 2020) lead authored by Professor Alice Stanton, a highly respected and senior medical researcher and clinician, struggled to find co-authors willing to appear on the paper. While very respected and senior researchers had agreed with the findings and statements outlined in the rebuttal, their institutions were not prepared to take the flack and said no. This was also a problem for their students trying to publish in the future. The question of how scientific intimidation should be addressed was discussed and agreed to be a global matter worthy of discussion in the ICoMST forum where perhaps a larger Meat Science group would provide safety in numbers as opposed to individuals losing promotions or ultimately their career. It was noted that this was not just an issue in meat science but also across the animal sciences.

9. **Points to be delivered in the ICoMST discussion.**
    i. The Australian model was one of collaborative projects rather than large independent centres. It has been successful in delivering for industry. Australia is a small pool requiring connections across universities and state departments. Australia has also had the ability to work across country rather than solely within country on meat research initiatives.
    ii. Scientific Intimidation was a serious concern
    iii. Need for Repositioning and Advocacy
    iv. Need to recruit students and make industry more exciting

5.6 ICoMST Special Session, Krakow, Poland

The International Congress of Meat Science and Technology is the annual major global Meat Science event attracting participants from over 50 countries over a week-long program. The expert group had discussed the 2030 initiative with the organising committee resulting in a special 2-hour session of the program dedicated to discussion under a session titled "The future role of meat science in underpinning a global sustainable meat sector for benefit to society while accelerating innovation - A Call to Action". Dr. Declan Troy of the expert group chaired the session with the format being short sharp 5-7 mins sessions of both physical and virtual attendees. Speakers were drawn from the AMPC 2030 expert forum (Dr. Declan Troy, Dr. Jean-Francois Hocquette, Dr. Mohammad Koohmaraie, Dr. Rod Polkinghorne) and from the previous RMC and Pathways sessions (Collette Kaster, Prof. Graham Gardner, Prof. Frank Dunshea) and from European/American academia and industry (John Gilliland, Prof. Frederic Leroy, Prof. Roger Clemens, Prof. Peter Pressman, Paolo Petruno, Andrew Sosnicki and Marzena Zajac) with the agenda and speakers shown in the appendix.

The ICoMST agenda, topics and speakers was developed by the expert group in conjunction with the ICoMST organisers and formed the basis for Declan's talking points in canvassing continued action to address agreed issues:

Setting the scene

It was outlined that we have a problem particularly when it comes to the engagement, promotion and acceptance of meat, meat science and the industry by the main stakeholders and in particularly global decision makers.

1. **The sustainability of meat science now and in the future**
   Many researchers have become very concerned about the future of meat science. Currently it faces 2 sets of problems; external and internal. Externally we are fighting with those that wish to see the industry disappear entirely and internally we are faced with the disappearance of government funded research institutions and the dramatic reduction in the number of universities focused on meat science and the number of scientists with basic meat science knowledge. Over the last 3-4 decades there has been a systematic assault on meat institutions. With governments dismantling research institutions, we are being pushed to seek more funding from industry. However, industry is only interested in the here now solutions and have little to no interest in funding long-term fundamental research. The industry needs to be made aware that without the fundamental understanding of basic meat science many of their problems cannot be solved. There is an urgent need for a formalized effort to combat these systematic attacks. For a successful approach this group is suggesting a global blueprint that can be shared and customised locally.

2. **The role of meat as a nutritional component of a healthy diet**

   Health care providers as well as educators should be pressured to communicate clearly and extensively about the scientific realities in this space. Globally, physicians have been terribly remiss in their clinical education where nutrition is concerned and even more in the critical reviewing of papers, causing considerable public mistrust of science. We need to educate scientists how to read a paper critically to enable them to assess whether or not the methodology makes sense and whether the data aligns with the stated conclusions.

3. **The role of livestock on contributing to a sustainable food system**

   Four key messages were highlighted in this session:
   i.   It's important that we recognise livestock deliver multiple public goods and not just nutritious food.
   ii. The livestock sectors greenhouse gas emissions must be calculated using lifecycle assessment calculators that deliver net and not just gross emissions.
   iii. The industry must embrace the innovation agenda to accelerate livestock sustainability to not only deliver on environmental health but also human health together
   iv. We must invest in developing smart metrics that can measure the outcome of food sources for both environmental and human health.

4. **The global perspectives**

   a. **USA** – covered in 5.4 of this report.
   b. **Australia** – covered in 5.5 of this report. The principal points presented reflecting the Australian perspective by Rod Polkinghorne and Graham Gardner are included in the appendix.
   c. **Europe** – Farm to Fork is the new European Union framework established to forge the future research agenda. On one note it was viewed as very positive detailing how sustainable food systems could be encouraged, but on the other hand, wherever meat is mentioned in the document it talks about the need for reducing its overall consumption. This is important because most governments will align their research agenda according to the European one and therefore the urgency of this debate reinforced by the need to showcase the importance of meat research and its crucial role in society.

5. **Industry perspective**

   The Farm to Fork strategy created a lot of frustration in the EU business community of the meat sector. With policymakers listening to organisations that don't always provide scientific based evidence, policy was seen as heading down a dangerous path. The meat industry is operating in a difficult space with a lot of fake news being circulated in mainstream media with cooperation between businesses, industry and researchers to deliver scientific based arguments to the public is needed now more than ever. Such resources are being developed to clarify the narrative and provide the tools to policymakers, research institutes, and consumers to make better informed decisions (The European Livestock Voice, Meat The Facts and ALEPH). Research

and innovation will soon become a priority for both the public and private sectors as the demand to produce more food from less resources continues to grow. The difficulty in this will lie in particular with the interaction between innovation and tradition requiring inclusive solutions as an approach.

The industry does not always understand how beneficial the academic research is or what it can do for them. This is in part due to the lack of, or poor communication from meat scientists back to industry, with much research still 'sitting on the shelf'.

6. **International best practice models**
    a. Australia – covered in 5.5 of this report and appendix items
    b. Ireland – Initially the state invested in universities and after a decade it wound down resulting from a lack of industry involvement. What was then introduced was similar to Australia, The Meat Technology Ireland (MTI) program which incorporated a technology center through Teagasc, genetic and genomic interaction with ICBF and core funded industry research organisation program where 30% is paid for by industry and 70% by the state. The incentive for industry involvement is they dictate program priorities and actively participate in program management with a second round of MTI commenced in November 2021.

7. **International collaborations**

The International Meat 3G Research Foundation is a not-for profit international eating quality research platform whose aim is to improve consumer satisfaction of meat products through fostering the application of global collaborative meat research knowledge throughout supply chains. IMR3GF will achieve this through the following actions:

   o Collaborative international research applied to commercial description and trading of beef
   o Collaborative international research for consumer sensory evaluation applied for continuous improvement in beef grading systems.
   o Facilitating the availability of eating quality tools, protocols and software to underpin collaborative projects and knowledge transfer.
   o Providing a global DATAbank of meat research data from participating countries to foster continuous improvement in eating quality prediction

Another example is the INTAQT project, entitled innovative tools for the assessment and authentication of chicken, meat, beef, and dairy product quality. This project is based on the one quality concept which includes health, taste and the safety of products for sustainability. This project started two months ago and includes 20 partners including the IMR3GF and also the European federation of animal science and other partners from nine countries. This project aims to relate livestock farming systems from intensive to organic and the characteristics of each including interactions with product quality for chicken, dairy and beef.

Better collaboration and communication strategies are urgently needed, particularly between key players in both the animal and meat science world, to provide the scientific evidence in a way that is meaningfully understood by consumers.

8. Communications and connections

There has been a paradigm shift, the foundation that once was physiological at the base, followed by a community layer, then status and esteem and at the top self-actualization has been tipped. There is now an over emphasis on self-actualization and status of the individual and the original foundation levels are instead being taken for granted. The anti-livestock agendas are benefitting from this shift and strategically attacking animal sourced foods, not so much from a nutritional aspect but more from a moral perspective of destroying the planet and selfishness. One communication strategy would be to demonstrate that this would lead to an emphasis on ultra-processed foods, corporate control of the food system and patented foods that would further increase the fragility of the supply system and further erode food culture and traditions. A better strategy would be to communicate the benefits that livestock and animal source foods can offer, in particular, bringing essential nutrition to regions that are suffering from micro and macro nutrient deficiencies that are optimally provided through animal sourced foods. Animal source foods are the cornerstone of traditional diets and if our communication strategies are successful, we may invert peoples' feelings of shame and convert them to pride. For this to be successful we must utilise the right communication channel, appropriates audiences and deliver robust and honest messaging.

One of the issues mentioned by meat scientists is that they often don't feel they have the backing of their organisation. So not only do we experience intimidation from outside but we also experience this internally.

9. Related activities and actions

The development of the 2030 discussions coincided and interacted with other local and global activities with the UNFSS and COP26 events engaging a wide audience and further interaction with many deeply involved in the 2030 project and identified issues. These included the ASAPP (Australian Sustainable Animal Protein Production) working group to engage with the Australian Department of Agriculture, Water and Environment (DAWE) regarding animal agriculture and input to the UNFSS and COP26 policy and interaction with the Global Meat Alliance (GMA) who were establishing global networking around a positive meat agenda. As part of the ASAPP activity a SharePoint site was constructed to assemble a very comprehensive library of relevant peer reviewed scientific papers and reports related to animal agriculture under major topics of health, environment and society. This resource seeks to provide easy access to high level facts-based summary information within each topic and the ability to easily drill down in increasing depth to the multitude of relevant papers and reports.

10. Urgent actions

The ICoMST program generated extensive discussion adding to the focus arising from the prior forums. Dr. Troy canvassed the proposition for an international Meat Science Summit in summing up the ICoMST session. This proposal was strongly endorsed by attendees and also supported by Prof. Frederic Leroy whose extensive engagement in monitoring anti-meat activism provided a new and highly relevant perspective as to how the current situation had developed and by what methods together with his recommendations for responding. He in turn introduced Prof. Peer Ederer who had an international economics background and had engaged in the animal sourced food debate through his involvement in African farming systems and realisation that the actual data was contrary to the populist anti-animal narrative and, in his view, would result in extreme negative outcomes for both the planet through climate

change and human populations, with the heaviest burden falling on the most vulnerable. He had been extensively engaged in the UNFSS and negotiated the proposal for a Livestock Coalition.

All parties were in agreement that an urgent science based effective narrative was needed for livestock and animal-based food systems. The proposed high-level summit was endorsed as an immediate vehicle to pursue this objective.

The entire debate can be viewed using the link below:
https://www.youtube.com/watch?v=TpAC6qWXWig

5.7 Planning for an International Summit on Livestock and Society

Following strong support for a major high level international summit arising from the special sessions at RMC, MSA Pathways and ICoMST a representative working group was established including several of the expert 2030 members. An initial small working group comprising Declan Troy, Rod Polkinghorne, Mohammad Koohmaraie, Collette Kaster, Graham Gardner, Peer Ederer and Frederic Leroy was charged with developing a conference proposal and engaging widely once primary topics were identified to ensure key global expertise was marshalled to assemble the principal peer reviewed science and to engage speakers who could communicate effectively to the target audience of high-level industry decision makers and government policy specialists.

Offers from Teagasc to host and meet the cost of the physical Summit in Ireland and of the AMSA to provide their virtual participation conference facilities with no charge were gratefully accepted and representative of the importance placed on the initiative. The Summit will be held in Dublin in October 2022 following the next RMC and ICoMST events that will again devote sessions to updating the issues.

It was agreed that the summit should be aimed at high level decision makers at CEO and board level and senior Government and UN policy makers providing a forum for factual and robust discussion of the issues and direct fact-based briefings and engagement with leading scientists expert in each sub topic. The summit will also provide a forum to directly engage industry policy and funding organisations including the AMPC and global equivalents in considering effective future collaborative models.

The points below are reproduced from a draft paper developed to summarise the summit objectives and desired outcomes.

It was proposed that the summit should address two major global issues; the reduction in meat and animal science resources and the extraordinarily successful attack on animal agriculture and meat from a very shallow but vocal minority. The Summit must simultaneously address both at a sufficiently high level to be effective but without being that fragmented that we lose focus.

It was proposed that conference topics could include:

1. **The science is solid!**

   Industry and stakeholders should commit to the Summit out of interest and concern and leave with increased confidence in the facts and committed to supporting facts-based decision making and the required foundation for this to expand.

2. **Livestock is the solution, not the problem!**

   We have to provide a very effective scientific presentation of the evidence in core areas of concern:

   i. Meat and human nutrition

    ii.   Meat and human health

    iii.   Livestock and biodiversity

    iv.   Livestock and emissions

    v.   Livestock systems and their role in land management

    vi.   Livestock systems and their critical societal role

These presentations need to be extremely strong, sufficiently detailed to engender confidence and delivered in very industry/stakeholder understandable terms.

3. **Everybody eats!**

We need to ensure that rather than Meat Science being viewed as an increasingly irrelevant and unattractive discipline it is accepted as a core essential and exciting dynamic contributor, integrated within multiple critical disciplines including medicine, nutrition, food science, culinary schools, environmental sciences, agronomy, soil science, business, law, engineering, communications and social sciences.

A transition to being acknowledged as an essential integrated component of almost every human endeavour and fulfilling the most basic human needs should return Meat Science to central relevance rather than being viewed as a declining and irrelevant historic artefact. The scale, future scale, economic and cultural relevance of our industry needs to be reinforced.

4. **The factual base for PSF (Plant Sourced Food) propositions**

    i.   Cell cultured meat

    ii.   Precision fermentation

    iii. Ultra-processed food creations

Clearly there is an essential nutritionally balanced role for plant and animal products in the human diet but what is the science relating to the much-hyped proposed new age alternatives.

5. **How have we got to where we are?**

We must consider the causes of the current decline.

    i.   Dramatic reduction in major publicly funded scientific institutions

    ii.   Academic disincentives to engage with industry; Rewards based on citations with effective industry engagement or impact unrecognised.

    iii. Perceived lack of relevance; why isn't our discipline the leader in climate and human

    iv. nutrition research development?

    v.   Inadequate effective collaboration

       -   Between industry and science

       -   Between University departments

       -   Between institutions

       -   Between industry and science with policy makers

       -   Between global groups.

    vi. Scientific intimidation. What is trustworthy science?

How and why has the current situation developed under our watch?

6. **Effective collaboration models**

Present examples of collaborative success

    i.   Irish MTI (Meat Technology Ireland), an industry and Government collaborative structure.

    ii.   Australian CRC (Cooperative Research Centres) encouraging institutional, industry and Government collaboration.

    iii. The IMR3GF (International Meat Research 3G Foundation), a not for profit for consumer sensory and related animal data storage, pooling and utilisation across institutions, industries and countries.

    iv. INTAQT. A 21 partner EU program collaborating to investigate farming system alternatives from organic to intensive.

    v.   ALEPH. A website created by Frederic Leroy and others dedicated to providing strong scientific evidence and discussion.

    vi. USA University and Government models including the Texas Tech Gift program.

    vii. Queens University Belfast. Model for integrating agriculture and medicine.

Which elements are effective and valuable? What are the downsides? What are the opportunities and interest in regard to more collaborative and effective access to data and results? How is scientific capacity maintained beyond individual projects? How is fundamental science encouraged?

7. **A way forward**

If the Summit can successfully and succinctly engage a broad high-level industry, government and institutional audience and deliver increased confidence and optimism, excitement even, then it should also foster ongoing discussion engaging all parties in mutual active consideration of future models and immediate coordinated collaborative actions. We must be relevant to society and a first point of call for decision makers.

This would look like success.

The discussion paper issues were discussed with agreement that the summit program will be arranged with direct reference to the most contentious industry issues:

◆ Animal sourced foods relationship to human nutrition and health

◆ The impact of livestock on biodiversity, emissions and land management

◆ Feeding 10 billion people within planetary boundaries; the role of livestock, alternative protein claims and realities, regenerative and traditional systems

◆ The critical societal role of livestock; animal welfare, a life worth living

◆ The sustainability and need for funding and effective interaction and support for the sciences and innovation including effective models

◆ The need for trusted comprehensive data relating to livestock and agricultural system interactions

The plan is to enlist expert groups within each major topic to consult widely, develop and refine the scientific evidence relating to each, ideally to a concise 2-page summary for incorporation into an overall statement, and to recommend expert speakers that can effectively communicate to the target audience of decision makers.

A successful outcome would deliver increased industry, government and scientific confidence and optimism and foster ongoing discussion engaging all parties in mutual evidence based active consideration of future models and immediate coordinated collaborative actions.

6.0 Discussion

The project has evolved and gained considerable depth through an extended engagement with a global network of scientific and industry leaders. The timeline, future direction, recommendations and a potential 'roadmap' from this engagement has been captured and summarised in this final report. It is hoped that the recommendations will be heavily relied upon for future decision making and next steps.

A primary outcome has been that the initial focus on "Meat Science" has matured into a realisation that "We all eat" and consideration of the desirable interaction between scientific disciplines and between science, industry, government and society.

The dramatic increase of ideological approaches supplanting fact-based decision making is recognised as a substantial risk for policy making across the scientific spectrum from animal agriculture and meat production to human nutrition and health outcomes that, when combined with environmental policy, has genuine serious implications for human, animal and planetary outcomes. The current trajectory of all three streams is not positive given the social media amplified noise from activist groups and must be redressed by a return to solid evidence-based policy.

Effective policy settings to foster high quality science and collaborative activity across disciplines, organisations and countries are required to efficiently deliver the scientific support needed in a period of intensive global change, driven by the need to provide adequate nutrition and health outcomes against environmental constraints to existing practice. Collaboration and funding models that encourage it together with strong industry, science and government linkage is core to success.

Meat Science has an exciting place in this transition due to its important linkage to animals and human nutrition through biological mechanisms and direct interaction with the commercial operations pre and post farm gate through to the consumer. Aside from core biology and data evaluation expertise increasing linkage to advanced engineering challenges in robotics application, food packaging and delivery systems expanding the need for interaction.

7.0 Conclusions

The report details major issues and related conclusions, assimilated into a proposed industry roadmap proposing actions to address the issues. The project timeline and future directions are summarised in Figure 1, with the "roadmap" providing further detail in 7.1

Figure 1. Meat Science Towards 2030 Timeline
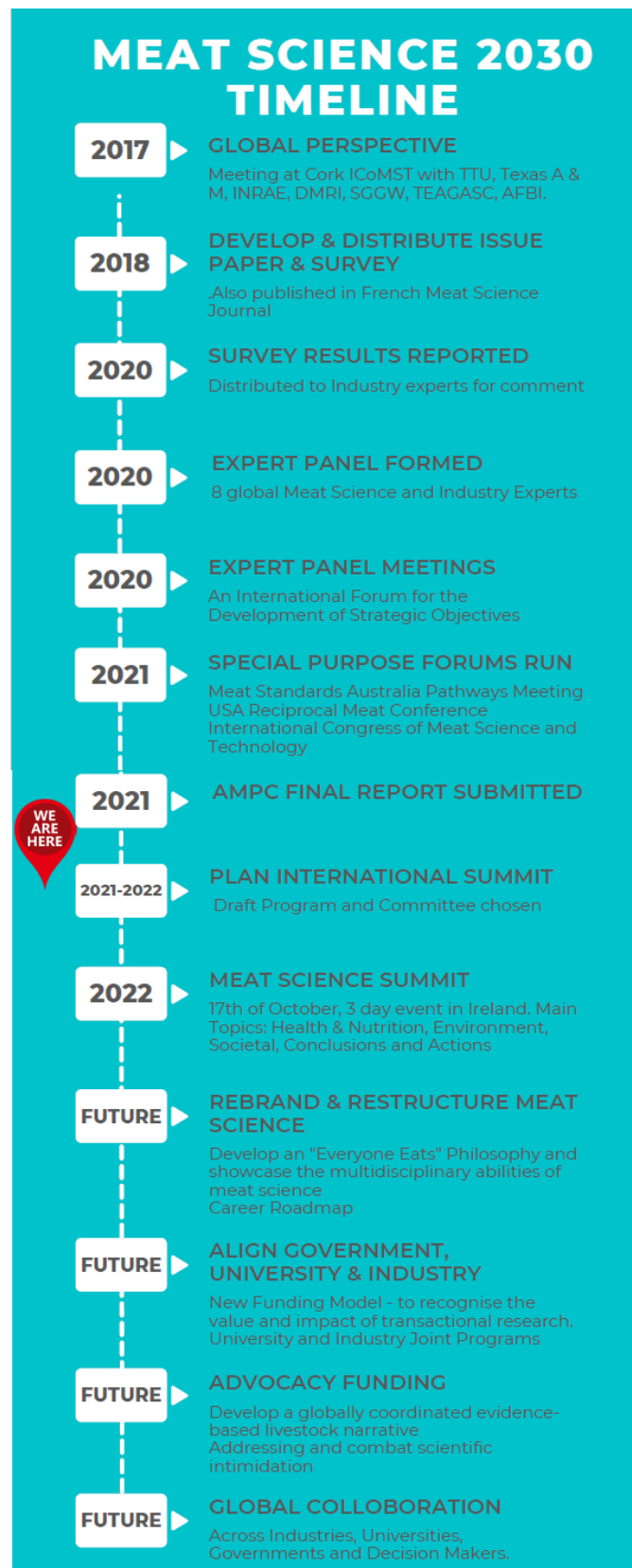
Principal conclusions, some drawn from the initial surveyed results and prior Milestones are summarised below.

1. A strong universal consensus exists that the Meat Industry and research community face serious threats that must be urgently addressed.

2. Threats include diminished resources in most countries and most institutions. Many previously major Meat Science and research bodies have either ceased to exist or had activity seriously curtailed over the past two decades. Not the least serious challenge is the declining ranks of expert and experienced personnel due to retirement with drastically reduced replacement numbers.

3. The current well organised and funded activity aimed at denigrating and, in extreme groups, destroying animal agriculture is a serious threat that requires equally organised response. The basis of this response should be soundly established scientific evidence including where necessary industry adoption of changed practices.

4. There is consensus that a globally coordinated evidence-based livestock narrative must be developed with sufficient funding to balance the ideological positions and anti-livestock and meat messaging from activist groups and their effective partial capture of Government and United Nations forums and policy positions.

5. It is believed that Australian and other Government active participation in the UNFSS related Livestock Coalition could significantly contribute to developing and delivering a more balanced fact-based narrative.

6. A major high level summit engaging industry and government decision makers with direct engagement to develop and strengthen processes that encourage collaboration, delivery efficiency and effective communication within and across institutions, countries and global organisations can be another important catalyst.

7. It is recognised that existing structures and funding competition most often impede large scale collaboration and that developing new approaches that encourage close across sector local and international collaboration is a significant challenge that must be addressed.

8. Engagement with Governments and universities is needed to advocate for academic and funding equivalent recognition for transactional commercial outcomes relative to academic publication and citation. Removal of additional overhead charges for industry related projects would encourage engagement as would recognition of academics who relate well with industry and deliver measurable economic benefit.

9. There is strong agreement that solutions require close and effective working arrangements between industry, educational and research groups over the long term with engagement of talented young people from a pre-University level and continuing in high priority managed programs that build engagement and commitment to a meat industry career. This must provide a highly skilled and empowered pool of future industry leaders with seamless links between education, research and commercial industry.

10. Meat Science should be actively integrated with other scientific disciplines throughout course structures to ensure effective interaction between scientists, teachers and students that ensure an understanding of the inherent interconnection of the Meat Science base ABC (Anatomy, Biology and Chemistry) within

multiple critical disciplines including medicine, nutrition, food science, culinary schools, environmental sciences, agronomy, soil science, business, law, engineering, communications and social sciences..

11.   Meat Science can be more positively projected through an "Everybody Eats" philosophy that establishes it as an exciting dynamic career choice. A transition to being acknowledged as an essential integrated component of almost every human endeavour fulfilling the most basic human needs should return Meat Science to central relevance rather than being viewed as a declining and irrelevant historic artefact. The scale, future scale, economic and cultural relevance of our industry needs to be reinforced.

12.   The growing incidence of scientific intimidation through ideological influences on scientific publication and departure from impartial evidence-based peer review needs to be addressed and recognised.

7.1   Recommended Meat Science 2030 Roadmap

Elements of a Meat Science Roadmap are presented below with recommendations presented within three core themes. Principal components are visually displayed in Figure 2 and summarised in Figure 3.

The roadmap addresses 3 key actions:

7.1.1   Changing the societal narrative. "Everybody Eats". Meat Science, and the meat industry, must engage across a broad sphere of disciplines and deliver and promote its fundamental relevance to healthy diets, healthy people and a healthy environment. The model must be collaborative across science, industry and government at a policy and planning level and engage people from early schooling to long term employment.

Recommendation 1: AMPC engage strongly in the **The Societal Role of Meat - What the Science Says - International Meat Science Summit 2022.**

The Summit will foster a robust discussion on the Societal Role of Meat.

Meat and meat consumption are frequent and easy targets for misinformation on a variety of topics. This summit intends to set the record straight by providing a full picture of both the positive and negative impact of meat.
At this summit we will hear the latest science on each of three topics: the Role of Meat in Diet and Health; the Role of Meat on the Environment; and the Role of Meat in Society, Economics, and Culture.
Each of these subject areas will be presented by global experts in each topic and will be followed by a robust discussion meant to provide additional insight, detail, and identify further information or research questions.
Attendees will be a broad audience of thought leaders including scientists, policymakers, governmental representatives, and constituents.
After the conference, thorough reviews of each topic will be published to contribute to the ongoing dialogue. The conference will by invitation and provide an opportunity for the Australian industry to actively influence a global reset from ideology to fact-based decision making.

AMPC can play a key role in encouraging and coordinating a strong Australian meat industry presence and in engaging with DAWE policy makers.

Recommendation 2: AMPC engage in the Livestock Coalition arising from the UN Food Systems Summit ensuring that the processing sector is fully engaged in promoting an integrated approach to livestock system evolution and strong fact-based communication from animal production to meat products.

Recommendation 3: AMPC further encourage and foster youth focussed programs that create lifetime interest in the industry around a "fun and fascinating" engagement. School, university and community activities including the ICMJ, livestock judging, the World Butcher Challenge, sausage, BBQ and other product creation and cooking competitions can all pique interest in the industry and re-set the image as a dynamic, challenging and exciting career path.

7.1.2 A new approach to teach and deliver Meat Science. The old system of single purpose well established Meat Science organisations is irretrievably gone creating an extreme risk for future capacity and fundamental science that is critical to support industry development in a highly technical era. Some of the science resides in other disciplines including medicine, veterinary and engineering/IT but these will not provide the industry specific adaption without active and persuasive structures that ensure interaction across disciplines and shared fundamental anatomy, biology and chemistry bases. Meat science cannot "live alone" but must be integrated and central to a much larger community.

Recommendation 4: AMPC actively engage in discussion with the TAFE and University sector to advocate integration of meat science as a core component of biological disciplines including medicine, human nutrition, food science, veterinary medicine and animal agriculture and as a major user of engineering, IT, human resources, finance and legal skills where meat industry challenges could be highly relevant case studies.
Useful models include Queens University (Belfast) where agriculture is grouped with medicine and food in the School of Biological Sciences which also houses the Institute for Global Food Security.

Recommendation 5: AMPC advocate strongly for a rigorous science-based structure for human nutrition studies and extension to dietary guidelines. Currently ideology and opinion often override fact in a critical discipline that is habitually built on poor science, not least due to the added difficulty of humans as research subjects.

Recommendation 6: AMPC encourage and pursue integrated pure science training structures where advanced biological training occurs in conjunction with medical, environmental, and other disciplines to expand resources and foster long term collaboration. Similar approaches would benefit engineering and other disciplines.

Recommendation 7: AMPC monitor industry related scientific integrity and contribute to establishing effective methods to call out misrepresentations.

7.1.3 Continuous expanded collaboration. Reduced and fragmented expertise and resources creates a global need for long term collaboration and supporting structures. These include increased reliance on industry and science linkage structures that provide long term incentives for active priority engagement. Structural issues include the need for continuous funding arrangements with effective review to ensure relevance and value, coupled with changes to academic evaluation and remuneration that values industry contribution equally to peer reviewed papers.

Recommendation 8: AMPC expand current levy leveraged funding models to enable longer term collaborative structures that provide attractive, subject to performance, career structures to engage young scientists. Current CRC and ALMTECH arrangements have provided excellent incentives for collaboration and young researcher development but also uncertainty of engagement over a longer career span for specialists.

Recommendation 9: AMPC encourage a review of academic evaluation criteria to ensure industry contribution and impact is formally rated in addition to peer reviewed publication. The UK structure of academic remuneration and evaluation having a set weighting for impact (moved from 5% to a suggested 45% over the past decade or so) to peer reviewed papers has been seen to stimulate engagement and could be a useful model.

Recommendation 10: AMPC pursue agreement with Government that high impact industry research at Australian universities be eligible for ARC Tier 1 funding status. This should be associated with agreement that industry projects attract zero or low overhead charges to encourage industry and university or other institutional collaboration.

Recommendation 11: AMPC encourage research delivery with a greater emphasis on industry access and early application relative to IP protection and prospective revenue.

Recommendation 12: AMPC seek to encourage and facilitate collaboration across institutions, both Australian and international, to create research teams of sufficient depth backed by adequate resources. This is of particular importance where subject experts are limited and widely dispersed, meat flavour being a good example.

Implementation of such a roadmap may be done in conjunction with other bodies depending on AMPC policy.

Possible collaboration partners for all or parts of the suggested roadmap:
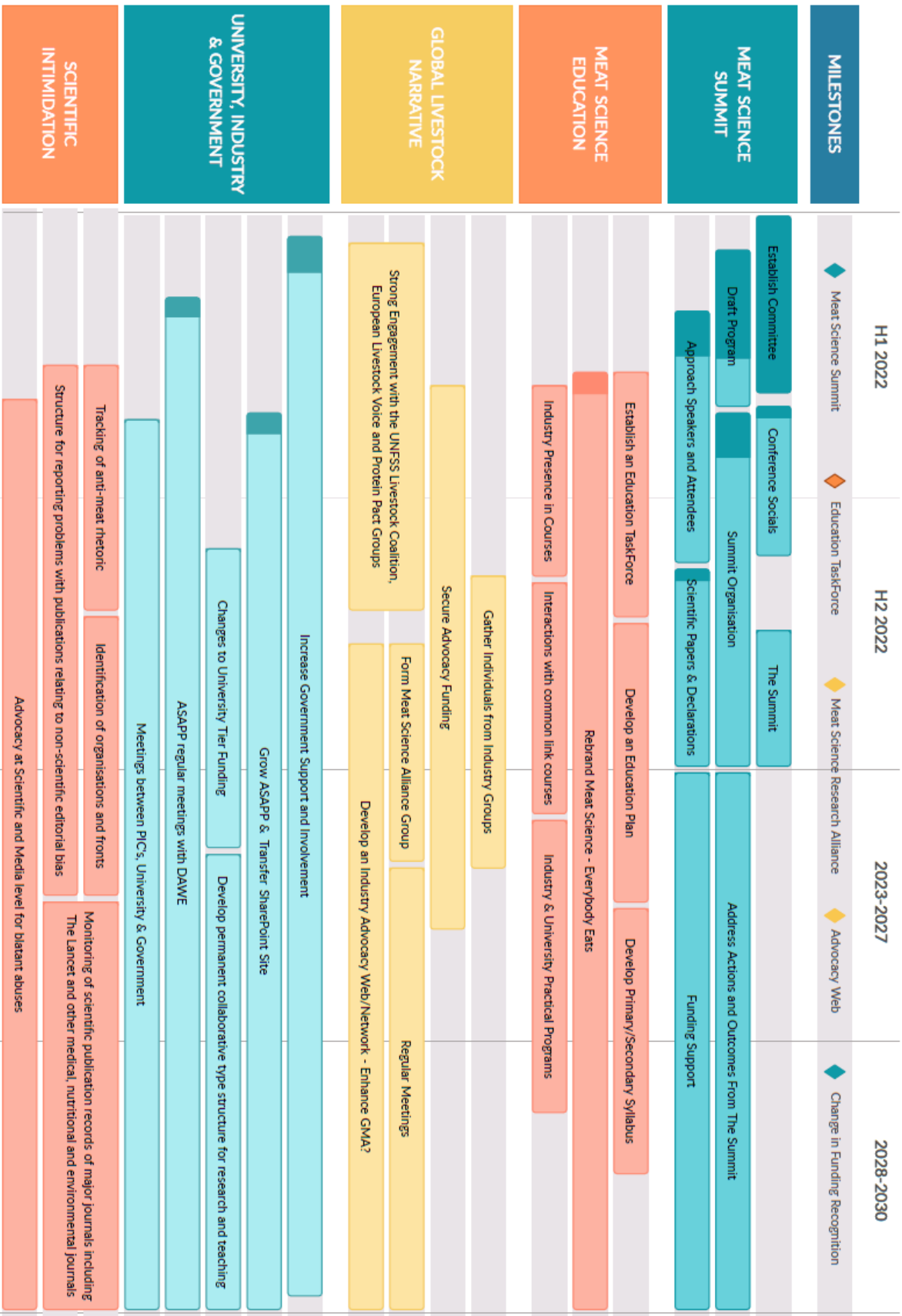
- **Within Australia**
    - MLA
    - RMAC
    - ASAPP including transfer of the SharePoint Resource to industry website
    - NFF
    - Reducing Food Waste CRC
    - DAWE
    - Department of Health including FSANZ
    - Dairy Australia
- **International**
    - Direct support and involvement in the International Meat Science Summit: The Societal Role of Meat - What The Science Says (Oct 19-20th 2022, Dublin)
    - GMA
    - IMS
    - ALEPH
    - NAMI
    - UCEBV
    - COPA COGECA
    - GRSB
    - UN Agencies – through IMS, IDF or direct.
        - Livestock Coalition

- FAO
- WHO

Figure 2. Meat Science Towards 2030 Recommendations

Figure 3. Recommended Meat Science Towards 2030 Roadmap

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9.0 Appendices

9.1 Invitation to Participate and Background Information
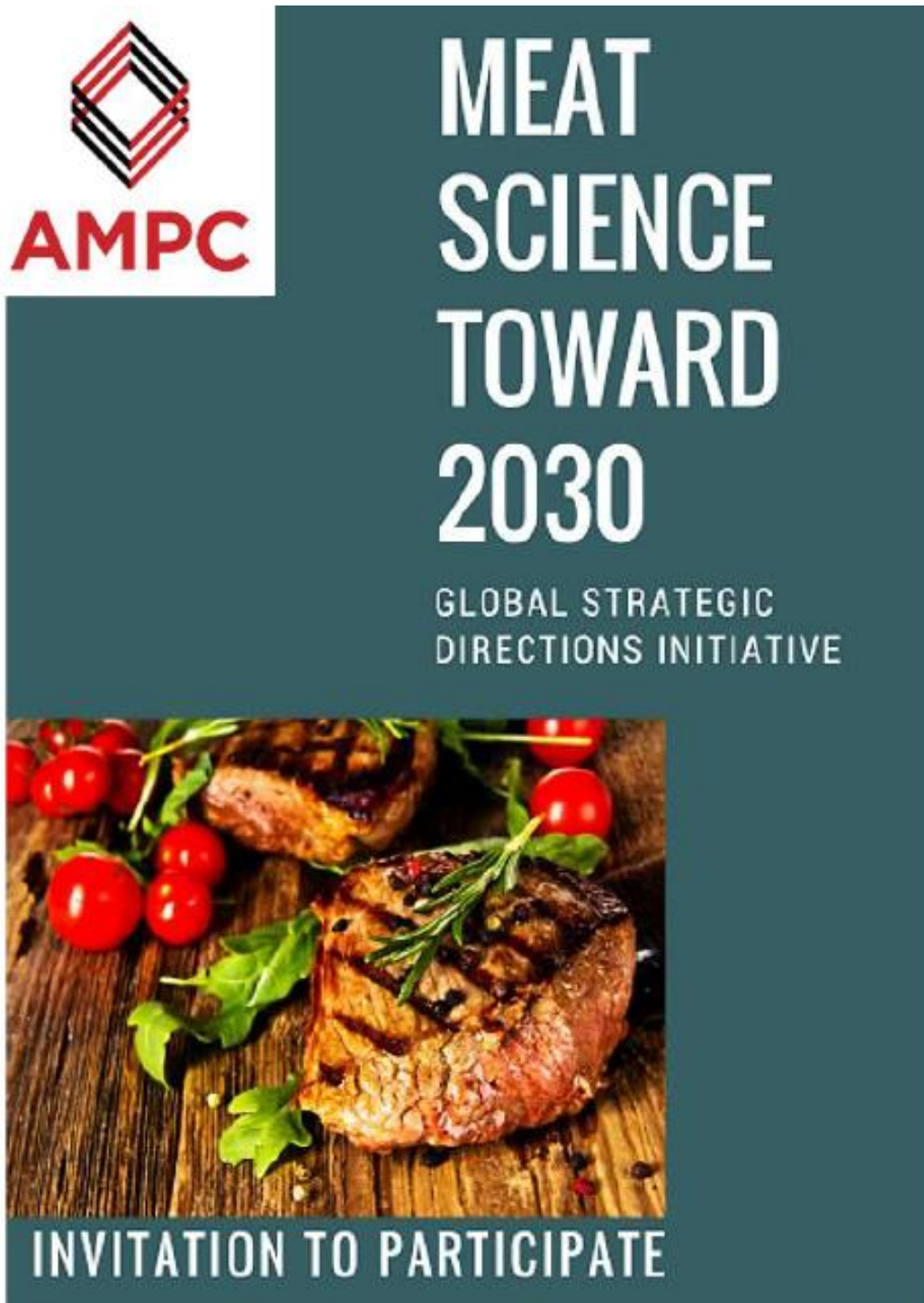
10th April 2018

RE: Meat Science Toward 2030 - Global Strategic Directions Initiative

This initiative has been taken by the Australian Meat Processor Corporation (AMPC) to frame a global strategy for future research funding. AMPC invests over $35million each year in red meat processor levies into research, development and extension programs that improve the sustainability and efficiency of the sector.

AMPC recognises that the viability of the red meat industry is intrinsically linked to meat science and has engaged Birkenwood International Pty Ltd to seek a global consensus view on research priorities for the next decade to optimise opportunities and outcomes from meat science research by:

- identifying strategic research streams to 2030

- fostering development of young meat scientists, and

- facilitating a new research model linking global expertise within collaborative research projects

This initiative presents internationally renowned meat scientists and young scientists with an invitation to address two questions: 1) What are the key challenges and opportunities for Meat Science over the next decade and 2) How do we harness Meat Science and related expertise into the future.

Following a review of submissions an imminent group of Meat Scientists from a number of countries and disciplines will be invited to join a Global Expert Group to meet and discuss these high level imperatives.

It is envisaged that invitees will participate as an individual rather than as a representative of an organisation, bringing their experience and personal views to the table in addition to any useful insights into institutional impediments or opportunities.

As a member of the Meat Science community or related discipline your participation and input will be greatly valued and of critical importance in allocating research funding against a considered strategy over the next decade and to build a strong base of meat science expertise into the future.

Yours sincerely,

Dr. Rod Polkinghorne OAM
Director,
Birkenwood International Pty Ltd
45 Church St, Hawthorn, Vic 3122
Australia

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MEAT SCIENCE TOWARD 2030 - GLOBAL STRATEGIC DIRECTIONS

INVITATION TO PARTICIPATE

PHASE 1

We invite you to submit your views in response to the following questions:

1) **What are the key challenges and opportunities for meat science toward 2030?**
2) **How do we harness meat science and related expertise into the future?**

Please submit online at: Meat Science Toward 2030. We welcome responses until June 30, 2018.

PHASE 2

Review of all submissions.
The submissions will inform the setting up of a **Global Meat Science Expert Group** and high level discussions within this group when convened in Phase 3.

PHASE 3

Convening of the **Global Meat Science Expert Group** for a 2-day meeting (location to be advised).
Members of the Meat Science Expert Group will receive funding towards personal time spent and travel.

It is anticipated that the outcomes of this meeting will include agreement on high-level strategies that address the identified challenges and opportunities out to 2030. These will include potential strategic approaches to encourage collaborative application of global resources and development of research talent together with an acceleration of knowledge transfer through enhanced industry and research interaction.

For information about AMPC please visit www.ampc.com.au

For information about Birkenwood International please visit www.birkenwood.org

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MEAT SCIENCE TOWARD 2030: GLOBAL STRATEGIC DIRECTIONS INITIATIVE BACKGROUND PAPER

Introduction

The viability of the Red Meat industry is intrinsically linked to the understanding and application of Meat Science. The Australian industry has high operating costs by global benchmarks. It is therefore imperative for the industry to create additional value through ongoing innovation in product and process to deliver consumer value.

The challenges are considerable, but exciting, and must be embraced with vigour to deliver an improved and sustainable future. The biological foundation of the product dictates that Meat Science is fundamental to the process and provides the Meat Science community the challenge to deliver the necessary knowledge for Industry to innovate.

Over time there have been a number of transformative technologies, underpinned by meat science and engineering application, that have fundamentally changed the red meat industry. These have included: refrigeration with the associated ability to ship product with extended shelf life over long distances creating global trade between the UK, South America and Australia; standardised carcase and cut description systems arising from market changes to enable remote trading of product unseen by the buyer and underpinned by audit and certification systems; vacuum packaging which facilitated distribution and export of chilled meat and trading of individual cuts, often to different markets from the one carcase and leading increasingly to combined slaughter and boning establishments supplying cuts to butchers rather than carcasses. (Case ready packaging systems may be viewed as a more recent development driving significant change in centralised packing and distribution arrangements).

What are the next transformative technologies and science required to enable application and adoption?

Which exist now but are at the early adoption stage requiring meat science and commercial input to realise their potential?

What are the blue sky opportunities yet to be fully articulated?

The AMPC has instigated and participated in major strategic planning activities to develop a clear strategic vision to ensure a sustainable industry and address identified threats. These encompass whole of industry collaboration and AMPC specific studies. These include the Australian Meat Industry Strategic Plan MISP 2020: http://rmac.com.au/wp-content/uploads/2016/12/MISP-2020-doc.pdf).

From these reports critical areas identified for Meat Science related actions include enhanced consumer understanding and interaction to provide improved value, improved supply chain collaboration, active development of a strategic innovation culture and global partnerships.

Your views and insights are sought and valued in gaining a broad perspective on where challenges and opportunity may lie and in formulating a coordinated and collaborative strategy. By taking a global view the

project aims to obtain diverse views arising from a wide range of local situations, to understand what has worked, what hasn't and why and to develop a structure that facilitates collaboration and mutual red meat industry advancement.

To stimulate discussion some background and identified issues that affect the Australian red meat industry are briefly outlined below. We encourage your input not to be restricted to these issues as new insights (both challenges and opportunities) or alternative positions are welcome.

Consumer Relationships and Product Value

As the sole source of industry revenue the ultimate consumer is of critical importance. The industry must understand the consumer in both local and global contexts, address issues of concern and provide a high value product that effectively competes with far lower cost competitive protein sources. Health and diet, declining consumption in developed countries, the percentage of beef and lamb consumption growth in developing markets and community interest in animal welfare and environmental issues have been identified as areas of significance.

Health and Wellbeing

The positioning of red meat as a preferred component in a healthy diet is a core issue. While not new it follows several decades of consistent industry attack from advocates who promote reducing or eliminating red meat consumption. Only recently has the wisdom of animal fats being a major dietary hazard been challenged successfully. What research is required to provide evidence of red meat health benefits? Where are the priority areas? Which negative issues are legitimate and may be addressed by research? Are there structures that can facilitate international collaboration in both research and dissemination of outcomes?

Animal Welfare

Community expectations are legitimately high for animal welfare standards. Industry recognises the relationship between a social licence to operate and animal welfare standards but there are also broader benefits in increased profitability through animal temperament and stress relationships to production efficiency, animal and human safety and, potentially, eating quality. Where can Meat Science improve welfare outcomes, community perceptions and profitability through improved performance? What practical stress indicators can be developed for on farm and abattoir use? Can FLIR, retinal scanning or other technologies improve management?

Improved and simplified product description

The expected result from most consumer goods is clear however the red meat consumer is often confronted with a confusing array of terms, cut names and claims from which they are expected to estimate a cooked meal outcome.

The AMPC strategic plan and MISP findings recognise that pricing pressures may put new product development and innovation at risk. Responses listed to mitigate price sensitivity include significant product differentiation through different grades of eating quality, packaging, product branding and service.

Most industry grading and description systems apply a common description to a carcase as a whole. These typically describe appearance (butt shape, muscle score, fat depth), sex, weight and age/maturity/dentition. Post slaughter descriptions based on observation of the loin surface at the quartering point include marbling, meat and fat colour and pH. The observed data is often utilised to create quality and yield grades applied at carcase level. None of these measures provide effective or simple description of a meal which is the critical consumer need.

The Australian Meat Standards Australia (MSA) system has further developed the use of carcase based inputs to create individual muscle eating quality estimates utilising untrained consumer evaluation as the primary measure. A change toward consumer based quality description of individual meal portions is seen by many as a fundamental driver of industry change. Further background reading is provided in the Australian Industry White Paper (www.ampc.com.au/uploads/Market/Aust-Beef-Language-White-Paper.pdf). What further research approaches may be useful to improve the ability to accurately estimate consumer satisfaction levels and enable related description and pricing systems?   What technical developments may facilitate objective estimates?

Technological Developments

The AMPC strategic plan acknowledges that the Australian industry operates under higher cost structures than competitors due to labour rates and regulatory imposts. To be internationally competitive it must aggressively innovate to justify higher pricing through superior product, and to must be implemented in concert with sound Meat Science imperatives to ensure product integrity is maintained. How should Meat Science, Engineering and Software disciplines be coordinated to encourage integration and facilitate practical commercial application?

Current areas of technological development initiatives are briefly discussed below.

Improved accuracy of carcase & muscle yield estimation & measurement

Traditional yield descriptors such as butt shape, external fat point measures, sex and dentition have known serious limitations. More sophisticated estimates as used in USDA and Japanese yield grades and in EUROP classification are superior but still only moderate in accuracy across populations. Individual cut identification and actual weight also offers a solution but requires technology that can operate at sufficient throughput.

Application of technology offers scope for substantial improvement with CT scanning regarded as the gold standard. DEXA has a current measure of acceptance in lamb processing and is at early evaluation stage for beef. Vision systems have been adopted for yield measures in some countries with RGBD camera technologies also being evaluated in live animal and carcase applications. What other technologies are on the horizon? How can meat science support development and application? How do we integrate engineers and software developers with Meat Science to optimise industry efficiency and consumer product value?

Man versus machine

Evaluation systems are rapidly evolving with increased sophistication in many instances associated with greater affordability where broader technologies such as those used in smartphones can be adapted for industry use. Further sophisticated technologies and robotics utilised in medicine, security, military and other areas may potentially be adapted for meat industry use. Camera and image analysis systems are currently in use for some traits such as marbling and rib fat depth and are promising greater potential as are a range of tools relying on spectra including NIR, Hyperspectral and Ramon. How do meat scientist's best engage and collaborate with the engineers? Are there smarter ways to interact with medical or other research developments?

Processing developments to improve yield, shelf life and eating quality

Processing systems can significantly impact yield, shelf life and eating quality with stunning, bleeding, carcase suspension, chilling, packaging and ageing all being critical and often inter-related. Chilling regimes vary widely including the use of spray chilling and various combinations of temperature, time, air flow and velocity. Research recommendations have differed in defining chill time (for example 10 hrs at 10 degrees followed by deep chilling or, at the other extreme very fast chilling) and in defining a temperature and pH relationship irrespective of time.

Previous research work has speculated on systems that may hot bone and differentially chill primals with more recent but limited application of other technologies to stretch, shape or prevent muscle shortening. Which technologies have the most potential? What research gaps exist to fully understand the mechanisms? What "blue sky" approaches are on the horizon?

Value-Adding Technology to Improve Consumer Value

Significant innovation is anticipated in value adding red meat as transferring the raw commodity into refined consumer meals offers greater value to the industry. Growing consumer concern over additives and a desire for "clean and green natural product" profiles presents challenges. Currently many value added processes are applied more extensively in pig and poultry processing and smallgoods but are rapidly expanding in red meat. Is the fundamental biology sufficiently understood to harness evolving processes? Can multiple levels of raw material quality be managed to produce a common outcome? Is there a balance between yield enhancement and consumer acceptance? What research is required to fully understand and interpret work to date?

Supply Chain Integration and Collaboration

Improved supply chain integration is seen as an essential basis for industry sustainability and reduced price fluctuation. In contrast to red meat sectors competing poultry and pig industries are characterised by vertical integration with commensurate communication, research and production linkage driving continuous improvement across production sectors. Direct consumer value signals being transferred throughout the supply chain is recognised as a pre-requisite to increase productivity and driver of improved performance.

Value assessment and communication in trading systems

Accurate value based trading systems across the supply chain offer the potential to transform industry efficiency. When accurately measured highly significant differences arise from both yield and quality variation across the carcase, both of which are poorly measured, reported and priced under most current systems. While the industry trades on averages the value range in cattle and carcase groups is masked. Current advances and research effort are aimed at providing the ability to accurately reflect value at each transaction point and to provide a genuine reflection of final consumer value from retail counter or restaurant menu to the value adding, processing, finishing, backgrounding and breeding segments. It can be argued that the continual long term productivity gains in industries such as dairy, pig and poultry reflect the accuracy of measurement and direct pricing linkage to products or components. What is needed from the meat science community to facilitate understanding of value drivers, accuracy and methodology of calculation and the cultural change that may be needed? Do meat scientists have a role in championing systemic change? What are the research needs to assist the process?

Genomics application throughout the supply chain

The AMPC strategic plan clearly identifies that farm suppliers must be profitable to ensure a sustainable industry. Overall industry profitability and stability is related to supply chain integration or collaboration. The processor role in providing accurate price signals and data to enable and encourage on farm adaption of genetic and management strategies for mutual benefit is acknowledged with funding encouraged for research that encompasses multiple supply chain sectors.

As the potential of any animal is set at conception, and reduced by subsequent actions, it is self-evident that genetics have an important interaction with meat science. Rapid and continuing advances in genomics have accelerated progress in the dairy industry across the globe, aided by pooling of genetic and production data through Interbull and collaborative analysis. The beef industry is yet to achieve the same rate of adoption but can clearly benefit greatly from similar application toward yield and quality. Data to date however is concentrated on the longissimus muscle and principally on shear force or other laboratory measures. What research is required to maximise the genomics opportunity and speed up application and adoption? Are there better mechanisms to encourage greater interaction between meat scientists and geneticists?

Live animal measures and management tools

Alternative breed, feed and management interactions have been studied for decades in relation to livestock performance and carcase based outcomes. What needs to be revisited in the light of new technologies and more recent research? What areas hold the greatest promise to encourage improved production of nutritious, delicious, affordable beef? Which technologies offer promise to accurately predict carcase composition or quality prior to kill? Can measures of temperament be used to reduce dark cutting by identifying individuals at risk and applying remediation on farm or in lairage?

Dramatic change in communication technologies is also facilitating extensive data exchange with potential to integrate producer and processor data for mutual benefit both through brand values relying on individual animal history and in adopting breeding and management systems to reflect value based payment and veterinary feedback from the processor.

The area of data exchange is of critical interest to AMPC and Meat & Livestock Australia (MLA) with recognition of the need to implement systems that facilitate uniform data collection and analysis techniques allied to commercial applications that can effectively manage and interpret "big data". How can complex megadata output from alternative technologies be interpreted for practical industry use? How do meat scientists interact in the development and utilisation of these technologies?

Fundamental Biology

Effective and efficient commercial application of meat science is fundamentally based on pure research that explains and quantifies the complex biology that explains "how things work" with emphasis on all aspects of the production of meat. Biological interactions critically impact the live animal and subsequent carcase biology is directly reflected in eating quality outcomes, muscle differences, ageing potential, cooking method interactions and consumer satisfaction. The live animal, carcase and consumer interactions need to be understood to mitigate and control the risk of benefits in one component relating to negative impacts in another.

Pure research knowledge development

The basic understanding of muscle biology is being continually expanded over time. Meat tenderness has long been studied but is there more to do? Flavour appears far less understood and more difficult to interpret than tenderness and may deserve more attention. The final eating experience clearly involves all facets and the combination of tenderness, juiciness and flavour with the development of each attribute both linked and resulting from myriad interactions and including connective tissue, protein components, enzymes and fat contributions in combination with pH and temperature conditions. Where is our basic science limiting? What is a sensible mix of pure and applied research? How can communication be improved to ensure effective collaboration between researchers and industry? What is required to engage young scientists and ensure future expertise?

Training and Development of the Next Generation

Highly developed skills are required to successfully operate in any business as complex as red meat and a new generation of leaders, industry professional managers and production staff must be trained, nurtured and developed to leave all industry segments in capable hands with solid growth prospects in a very competitive environment. New approaches will be required to foster the development of an open innovation network and requisite attitudes and competence. More than ever before interpersonal, inter-company and international R&D and extension relationships will be required to develop, deliver and optimise opportunities created by accelerated innovation. How can the industry build interest in a meat industry career and attract the best and brightest? How can a seamless multilevel system that accommodates basic practical skill training to high end science be facilitated and nurtured?

AMPC envisages transitioning from RD&E facilitation to developing and leading an industry culture change toward operating within thought leader resource networks to an open innovation network. This involves harnessing the world's best ideas and leading practices in the process of building enduring industry relationships and a growing dynamic network of service providers.

Research Collaboration within a Competitive Environment

Under current funding models most research is funded by competitive grant. By nature this engages institutions and individuals in a competitive rather than collaborative framework and may not always deliver the best or most efficient solution with reducing funding increasing the pressure. Further, private funding models and concentration on IP ownership can limit accessibility to the broader industry. Concurrently however decreasing resources might be more efficiently utilised by specialisation and collaboration between centres of excellence. A related problem is ensuring the legacy of experienced researchers is not lost but passed on and that the brightest and best young scientists are nurtured to ensure continuity and viable future meat science capacity by attracting and retaining the best. What are appropriate principles to optimise research outcomes? How can local and international collaboration be best encouraged?

Bridging the Gap between Science and Industry Adoption

Traditionally in the red meat industry there has been a significant time lag between research initiation, conclusions and industry adoption. Part of this may reflect communication issues or the lack of clear commercial benefit from adopting new findings. What are/have been the impediments to rapid research adoption? What structural research arrangements can improve adoption? Is there a process that can better facilitate a smooth linkage from pure science to applied science to commercial application?

9.2 ICoMST Debate Agenda

Tuesday 24ᵗʰ August

11.00 – 12.42 h Warsaw Time

Call to Acton

"The future role of meat science in underpinning a global sustainable meat sector for the benefit to society while accelerating innovation"

Agenda

Declan Troy Chair

1. ***Setting the scene***. D.Troy 11 to 11.10. a. Objectives, b. grand challenges c. why now d. actions needed e. who and f. how.
2. ***The sustainability of meat science now and in the future***. M Koohmaraie 11.10 to 11.17. a. current problems b. impacts for academia, research and industry c. what can help.

3. ***The role of meat as a nutritional component of a healthy diet***. Roger Clemens and Peter Pressman 11.17 to 11.24. a. what is science telling us, b. what are the most important messages to get across c. who should deliver these messages?

4. ***The role of livestock in contributing to a sustainable food system***. John Gilliland (by video) 11.24 to 11.31. a. what is science telling us, b. what are the most important messages to get across c. who should deliver these messages.
5. ***The global perspectives*** – US, AMSA (Collette Kaster) 11.31 to 11.36, Australia (R. Polkinghorne) 11.36 to 11.41, Europe (Declan Troy) 11.41 to 11.46.
6. ***Industry perspectives***. Nominee from Smithfield (Fresh Meat) 11.46 to11.53 a. what is needed from industry, research and policy makers. Paolo Petruno (CLITRAVI) 11.53 to 12.00 a. what is needed from industry, research and policy makers. Andrew Sosnicki (PCI) 12.00 to 12.07 a. is industry properly served by meat scientists and research funding agencies b. where are the gaps c. what is needed for a vibrant innovative meat industry?

7. ***International best practice models***. Australia's ALMTECH, MSA, CRC (Beef and Sheep) Graham Gardner 12.07 to 12.12, Ireland's MTI John Colreavy 12.12 to 12.17.
8. ***International collaborations*** Jean-Francois Hocquette 12.17 to 12.22 a. example and b. what's needed for more.
9. **Communications and connections**. Frederic Leroy 12.22 to 12.27. a the who, b the what and c the how. Scientific intimidation Frank Dunshea 12.27 to 12.32 a. the pitfalls b. can we be braver. Marzena Zając 12.32 to 12.37 a. Being a meat scientist to-day : a career with a challenge, b how we should communicate to attract next generation post grads in meat science
10. ***Urgent actions!*** DeclanTroy 12.35 to 12.42 a. Organise ourselves b. articulate actions, c. identify and make key connections d. call an International Meat Science Summit

9.3 Future of Meat Science, An Australian Perspective

THE FUTURE OF MEAT SCIENCE – Australian perspective (Dr. Rod Polkinghorne)

1. Our MSA Pathways group listened to the RMC session which was a valuable starting point.

2. Australia also experienced a massive decline in traditional Meat Science research over 30 years with dismantling of the CSIRO Cannon Hill facility and significant reductions in State Government establishments and teams. New Zealand followed a similar path with MIRINZ.

3. An unexpected but fortunate consequence was that the decline in legacy institutions forced collaboration between multiple groups and with industry which has had many positive outcomes.

4. GG will discuss further but one example is the MSA grading program that has continued to grow over 20 years, funded by industry and driving producer, processor, retailer and scientific interaction for mutual benefit. The structure of having a science-based Pathways Team charged with acting strictly on evidence from untrained consumer assessment and with industry knowledge but independent of industry politics has proved extremely effective. While forged in fire the program has made a massive industry impact and engaged the whole supply chain to an unprecedented extent, now grading 3.5 million cattle per year.

5. Collaborative industry programs are however mostly for limited time periods and generally focussed on shorter term applied outcomes. We are fortunate that our industry provides substantial levy funding but more stable funding of basic research and continued industry collaboration is critical.

6. University staff assessment criteria currently inhibits industry collaboration by discounting industry relevance and economic contribution relative to publications and citations. Government funding related to research categories also creates challenges where applied research and extension contributions to industry are not appropriately valued relative to their economic impact.

7. We are experiencing the same relentless ideological non-scientific attack on red meat with unfounded assertions in regard to human health, animal welfare and environmental damage. The environment of ideological agendas overpowering sound science has caught our industry by surprise and we are now having to play catch-up. We have to counter these attacks with solid science presented in Gen Z savvy communication forms to ensure we are heard loudly and respected by Governments and consumers.

8. Meat Science must get out of its silo and be presented as a critical knowledge base, delivering fulfilling careers, full of excitement and the potential to assist and engage with other disciplines including medicine and nutrition, to deliver improved human health, environmental outcomes and to be a critical component of feeding a global population of 10 billion, all built on our traditional biochemical base.

9. Above all else we need greater collaboration, both locally and internationally, to communicate effectively and ensure that red meat and the fundamental scientific base continue to serve a critical role in feeding a hungry world.

9.4 Industry Challenges, An Australia Perspective

THE INDUSTRY CHALLENGES – Australian perspective (Prof. Graham Gardner)

I've decided that there's 3 things that I would like to tell you about.

1. The challenges to Australian research
2. Collaborative structures to address these challenges
3. And a good recent example

Firstly… our challenges.

a) We're a small group of scientists in a small nation – and the meat science community is smaller still!
b) We're isolated
c) We've had diminishing government investment – particularly through the state-based departments of Ag

Secondly

a) We've responded to this by creating Cooperative Research Centres. These pool industry levies and government funds to undertake "projects of scale" across institutions that any individual group could not tackle.
b) They are focused on solving big industry challenges
c) And crucially they enable us to punch above our weight class scientifically.
d) Excellent examples include the Beef CRC and the Sheep CRC – each of which spanned terms of about 20 years. Indeed, my entire early career was embedded within them.
e) Outcomes include the first variants of the beef and sheep meat MSA models, enhancing the robustness of range of traits within our modern breeding programs, and even embedding our current nucleus flock and herd approach to accelerating genetic gain.
f) So, these have been particularly successful at enhancing the link between meat science and genetics.

Now the CRC's have a finite term, so this brings me to:

Thirdly

a) Which is an example of an existing project. While this isn't a CRC, it has still adopted the CRC model in its collaborative structure.
b) It's called the Advanced Livestock Measurement Technologies project and is focused on developing new technologies to measure LMY and EQ.
c) It also integrates the data generated into industry feedback systems, genetic databases, and business decision systems.
d) This brings together a multi-disciplinary team, of meat scientists, engineers, geneticists, and business analysts.
e) The crucial thing is that like the CRCs before it we have industry co-investors that are also collaborators.

f) Where-ever possible, our lab is on-farm and in the abattoir, meaning that we are developing these technologies hand-in-hand with the end-user, so that when we walk away the adoption step is already complete.

g) This means that outcomes aren't just scientific – they're industry changing and have a quantifiable economic impact!