NMSP WP – Food Security – Food Safety and Innovation

a. Abstract

Food security occurs when there is access to sustainable, safe and nutritious food (FAO, 1996). The safe and nutritious components of this are often unseen, but remain the foundation of seafood trade and market access domestically and globally. Maintaining core capability in this field is essential to maintaining and building the wild harvest and aquaculture seafood sectors. Changing seafood markets and consumer preferences are driving innovation. Climate change, new packaging environments, longer supply chains and changing international regulations present emerging food safety hazards to be considered and managed in a cost-effective manner. Furthermore, food safety incidents can have damaging impact on markets; without core capability incident response is hampered, damaging brand which transfers across all seafood trade.

b. Background

The trade in all seafood, whether it be aquaculture or wild-harvest, is facilitated by food safety. Consumers and regulators alike are becoming more educated on the potential hazards associated with their food supply such that food safety is no longer a point of differentiation, but a 'given' required for trade and market access in the domestic and global economies.

Significant changes in seafood markets, supply chains and information availability are reshaping consumer (and therefore market) preferences. In order to maintain market share, seafood businesses need to address consumer demands to demonstrate safety and supply quality, convenient and nutritious products.

Seafood safety research in Australia is a relatively small field, primarily conducted through SARDI, CSIRO, UTAS, QDAFF and Curtin University. Seafood innovation and quality are researched in these institutes, as well as a range of other universities.

Whilst seafood safety has long been studied in Australia, a national approach to this area is relatively recent. The seafood industry commissioned a semi-quantitative risk ranking of seafood hazard-commodity pairs in 2001 to inform future research investment (Sumner & Ross, 2002). Further national approaches to seafood safety were the development of the Seafood Primary Processing and Production Standard by FSANZ in 2005, following extensive risk assessments and identification of high risk foods (FSANZ, 2005). The Australian Seafood CRC (ASCRC) commissioned further work examining food safety risks and capability in the Australian seafood sector to inform the seafood market security program, including SafeFish.

Research in these areas adds to the international perception of Australia as a producer of high quality safe food, leading to increased demand for Australian product. In 2012, Australia was ranked as the 4th OECD country in the Food Safety Performance World Rankings[1]. It is difficult to assess the international competitiveness of research in the seafood safety field. The recent ability to influence the development of international food standards through the research program SafeFish indicates that Australian research is well received globally as credible and independent. Furthermore, Australian researchers and government officials are often involved in FAO/WHO/UNESCO expert working groups around seafood safety risk assessment and risk management, indicating high international standing in this field.

There are a wide variety of organisations researching innovation in seafood products in Australia. A large proportion of Australian seafood is sold live, or as fresh chilled product with minimal processing

[1] http://safepackaging.eu/526

and packaging. Opportunities exist to diversify into novel packaging and product formats in line with international developments.

Research into waste utilisation has been hampered by the generally small size and geographically segregated nature of the processing industry. Several recent initiatives, such as the proposed Safe and Saved Food CRC highlighted an appetite for research in this area. There is potential to increase profitability and maximise yield from catch through increased use of raw material via transformation in value-added, high quality packaged foods.

Funding sources vary. Food safety aspects are often funded by ASCRC, FRDC and State Government authorities. Resolution of trade and market access issues is funded by industry, often with input from the funding bodies. Seafood innovation, quality and packaging research are more likely to be funded by direct investment of companies along the whole supply chain; although this has also been a focus of the ASCRC with work undertaken on quality optimisation and new product development.

c. Relevance

Food safety across the supply chain and other post-harvest activities such as new product development are directly relevant to ensuring food security in Australia. These activities ensure protection and expansion of the market, enabling high demand and market access for seafood products, which translates to profitable activities for seafood businesses.

The beneficiaries of research into food safety and innovation are:

- Seafood primary producers (both aquaculture and wild harvest): without safe and appealing products, there is no market;
- Seafood processors: innovation in products, packaging, and waste minimisation all lead to improved profitability;
- Seafood transport companies, wholesalers and retailers: returns are related to seafood sales volumes, food safety risks exist throughout the supply chain, innovation allows longer supply chains and access to more distant markets;
- Importers and exporters, both in terms of additional products and the resolution of trade and market access issues;
- Consumers through access to safe and nutritious food;
- Regulators through risk assessment to identify high priority issues, and advice of effective risk management options;
- The wider Australian community benefits from protection of food security and reduction of the public health burden associated with food borne illness;
- Recreational fishers through knowledge of hazards associated with seafood and how to manage them, also through more effective management of regional contamination events of seafood e.g. marine biotoxins;
- Regional communities through the maintenance of profitable and active seafood industries providing employment and trade opportunities.

Evidence of end user engagement in this field of research includes:

- Support for trade and market access programs such as SafeFish – several seafood industry bodies have committed future funds towards the operation of trade and market access research after the ASCRC closes (including rocklobster, abalone, oysters and mussels).
- The current level of State grants applied for and provided to seafood SMEs for new product development.

- The inclusion of seafood waste reduction as a funded project proposal in the proposed Safe and Saved Food CRC bid.
- Current research on novel diagnostics for paralytic shellfish toxins and an acknowledged need to increase biotoxin monitoring amongst the shellfish industry.

d. Science needs

The key challenges for Food Safety and Innovation and likely outcomes of investment in the seafood arena are:

Improving capability for screening techniques for rapid, sensitive, cheap, reliable detection of pathogens and contaminants in the food industry.

The time to assess the risk of seafood products using current detection technologies is a significant issue for industry as delays in analysis (up to several days) can impact harvest and transport strategies. Furthermore, limitation in both sensitivity and specificity of some current best practice detection methodologies may occasionally result in high risk products being present within the marketplace. Rapid, sensitive, cost-effective and on-site detection methodologies would allow industry to be proactive, making increased testing for pathogens and contaminants financially viable and reducing testing turnaround times. This would allow industry to make timely decisions, either about product quality or safety, thus improving decisions that may flow from here (e.g. suitability for harvest, requirement/suitability for additional processing, potential risk management options). Examples include norovirus in oysters, ciguatoxins in finfish, marine biotoxins in seafood.

Better risk management in the seafood industry has significant flow on for the Australian economy. For example, in March 2013, 525 people were reportedly affected by NoV following consumption of contaminated oysters produced in Tasmania (Lodo, Veitch, & Green, 2014). In 2009-2010, oysters ranked in the top five of Australian fisheries production by volume (14,807 t), accounting for 6% of the national fisheries production (ABARES, 2011). It has been estimated that in the event that an oyster derived NoV event occurs twice a year the cost to health, welfare loss and loss of life would be $11.8 million/year. Sensitive, rapid diagnostics would assist in managing this issue and others like it, reducing the cost to the national economy.

Improved quality and value, minimisation/utilisation of waste.

The cost of new product development and innovation in seafood businesses is an expensive and daunting task; particularly for small seafood processors. Poorly constructed products can be damaging to brands and new products may also result in new product/pathogen combinations that could lead to damaging food safety incidents or recall events. Whilst the large seafood companies often have internal access to specialist skills, access to affordable research can be a roadblock to the development of innovation in much of the seafood industry. The ASCRC has developed significant capacity and networks in this area through investment in scientific capacity; however, this capacity will dwindle without ongoing investment.

The seafood processing sector generates a significant amount of waste. An estimated 10,000 t of seafood processing waste is currently disposed of into land-fill as it is produced in many locations in volumes that are below the minimum for cost-effective processing. Other waste includes packaging

materials and inefficiencies in labor. Furthermore, approximately 25,000 t of finfish are not harvested in Australia each year, due to low market value, short shelf-life or difficulties in supply or distribution. Utilisation of these species to generate profit is a key challenge, but also an opportunity for the Australian seafood industry. As markets and trade expand there is a greater effort spent to maintain product quality and extend the shelf-life of the products.

Investment in improving seafood quality and transforming waste will allow new technologies to: develop to reduce loss from the value chain prior to processing; increase the value of seafood harvested; improve product recovery rates and utilisation of low value species reducing industry waste; improve supply chain dynamics; allow incorporation of active and smart packaging options to seafood to indicate product quality and integrity; all of which enable the seafood industry to adjust to changes and consumer demands whilst maintaining profitability.

Improved capability and capacity in the marine biotoxin field.

Marine biotoxins have recently had significant impacts on the seafood sector, emerging as one of the key food safety issues to be addressed at a sector wide level, as evidenced by the Tasmanian East Coast event in 2012, with a direct cost to industry of AU$8.6 million (Campbell, 2013). Marine biotoxins include ciguatoxins in finfish, and shellfish toxins across a range of seafood vectors. Ciguatoxins in finfish are the leading cause for foodborne illness relating to seafood in Australia (Sumner, 2011). Although usually found in the tropics the causative organism has recently been detected in southern NSW (Kohli et al., 2014), and ciguatoxin fish have caused illness in NSW for the first time in 2014. Shellfish toxins are commonly associated with bivalve filter feeders, but have recently been impacting on high value non-traditional seafood vectors such as rock lobster and abalone. The seafood industry is grappling with management of this food safety risk, at an aquaculture and wild fishery level. Risk to business is not only from public health and reputation loss, but also a trade and market access risk.

Improvement in knowledge of the ecology underlying the occurrence of harmful algal blooms will allow improved prediction and risk management and potentially mitigation of harmful algal bloom impacts, likely to become more important due to the impact of climate change. Rapid screening tests for a number of toxin groups will allow seafood operators to manage their business risks, as well as improve management of public health risks. Risk management options for ciguatoxin in particular need to be validated, and are likely to improve access to geographic sites and size ranges of species currently restricted by the precautionary approach necessitated through the lack of validated information. Fast, effective incident management will result from increased knowledge, and will reduce the effects of future events likely to impact on a regional scale.

Traceability.

Traceability of products in the event of a food safety incident is paramount to effective mitigation of an event. While some Australian seafood industries have stringent traceability requirements in place (such as bivalve shellfish) others lag behind. This is also confounded through complex supply chains where the final destination of product is sometimes unknown. Traceability is an emerging international requirement with the EU bringing in full trace-back requirements for all seafood and the US developing trace-back guidelines. The majority of the Australian seafood industry is not well prepared for these changes, and practical, cost effective mechanisms need to be investigated.

Traceability options vary for the seafood being considered. Innovative automated systems can have additional flow on benefits throughout the supply chain by improving product inventory, and allowing mechanisms for proving integrity and provenance. However, not all sectors will be able to afford these high end options, and further research will allow traceability options suitable to each sector's requirements.

Trade and market access research.

Export markets comprise approximately 52% of the Australian seafood market (Skirtun, 2013). In order to maintain trade, food safety issues must be adequately addressed. Additional effort is required to ensure that emerging domestic and international regulation is commensurate with risk and cost effective. Independent research is required to underpin the above, to provide technical advice to resolve technical barriers to trade and support risk management decisions within Australia. This research will assist to minimise food safety incidents, thus protecting Australia's access to export markets.

The success of SafeFish (a trade and market access research program run through the Seafood CRC) has shown that independent research reports have an impact in resolving trade disputes, and ensuring developing international regulation is risk commensurate and appropriate for the Australian setting. Such research not only sustains free and fair access to key markets, but also builds on Australian seafood safety and hygiene credentials and acts as a marketing tool for the industry.

Global warming and unusual weather events.

Increasing sea temperatures associated with global warming and other weather related events presents a challenge to the seafood industry. Changing ocean dynamics can lead to changes in indigenous hazards such as biotoxins and bacterial pathogens such as *Vibrio.* As an example, in 2004 Chile had a significant food poisoning event associated with the bacterial pathogen *Vibrio parahaemolyticus* that occurred in-line with an *El nino* event where 10,000 individuals became ill (Heitmann et al. 2005). Prior to this time this pathogen had rarely caused illness in Chile. The Australian industry must be prepared to respond to these invents in order to mitigate the loss of seafood sales that reverberate throughout the seafood industry following such an event.

e. Perspective

Improving capability for screening techniques for rapid, sensitive, cheap, reliable detection of pathogens and contaminants in the food industry

The presence of unsafe levels of chemical compounds, toxins, and pathogens in food constitutes a growing public health problem that necessitates new technology for the detection of these contaminants along the food continuum from production to consumption. Many current food safety diagnostic methods have limitations in sensitivity, specificity, discrimination of viable particles, the requirement for expert personnel and laboratories to run tests and interpret results. They are often time consuming and expensive. Short term research needs to focus on building the processes to develop new technologies, including increasing national and international collaborations.

Internationally there is much research being undertaken into developing rapid diagnostics based on biosensors. The main components of a biosensor are the "bioreceptor", which directly interacts with the target (pathogen, toxin or chemical), and the "transducer", which transforms this interaction into a physical or chemical response. To be successful this specialised field of research, the short term needs are to unite experts in biology (development of bioreceptors such as antibodies, aptamers, and synthetic antigens) with the experts in physical and chemical aspects to be able to successfully produce a functional biosensor. Being a relatively new field of research it is often segmented with biologist and physicists/chemists working in isolation and not understanding industry needs. SARDI has developed capability in this area through support from the ASCRC. SARDI has identified and engaged with both national and international collaborators in developing a biosensor for norovirus detection in the shellfish industry.

In the longer term (5 – 10 years) the focus should be on commercialising the sensors, and adapting for use in the field or on site (including inline in processing systems), although it is projected that realisation is still some time off (Mortari & Lorenzelli, 2014). This time frame will also see the need for the ability to sense modern risks such as antibiotics, PCBs and nano-particles at highly sensitive levels.

Quality and value-add.

The majority of seafood processors in Australia are quite small and handle a number of species on any given day. There is a need to develop lean manufacturing technology, especially efficient automation systems to cope with multiple species. The ASCRC has established a post-harvest research hub to improve collaboration between leading research agencies. Priorities over the next 5 years should be to strengthen these networks and engage seafood processing plants, automation and equipment providers to benchmark and implement lean manufacturing practices within processing plants. Other scientific priorities should be to develop and implement technologies to reduce waste and meet consumer demands (i.e. improvement in packaging and packaging materials, recovery of higher-valued products, new product development).

Marine biotoxins.

Considerable international effort is being placed in this area recently. It is an area of rapidly growing research, regulation and international awareness. There is a high need particularly for ciguatoxin research in the Asia Pacific area. There are currently good collaborations between Australian and NZ researchers in the marine biotoxin area, particularly in abalone and rock lobster research that could be built on. The New Zealanders are world leaders in testing methodologies in this field. Priorities over the next 5 years would be to strengthen national and trans-Tasman networks between researchers in this field, and to improve diagnostic and research capacity and capability, both of which are limited in Australia. Research should focus in the short term on developing and validating rapid screening techniques; in understanding the basics in uptake mechanisms; which toxins are a hazard in Australia and which species are at risk; whether processing is a viable option for hazard reduction; and validation of current ciguatoxin management protocols. Following this the next 10 years should focus

on improving risk management options to reduce monitoring and management costs in a risk commensurate manner that allows continued access to domestic and international markets. Further long term research (5-20 years) should focus on predicting bloom events and improving additional monitoring tools such as genetic identification of toxic algae, and remote in-situ monitors.

Traceability

Traceability is an emerging issue in the seafood industry. As many products have been considered low risk food groups in the past they have not been subjected to traceability requirements, the obvious exception being bivalve molluscs that are required to have trace back to harvest area and date of harvest. Recent food safety incidents have highlighted the restricted management options available for incident control when traceability is not present (Campbell, 2013). Traceability regulations are increasing in importing countries, some of which will impact on the Australian market in the next few years.

Options for traceability are therefore an immediate research need. Innovative products are available but need to be investigated and "tweaked" for application to seafood from point of harvest. The immediate focus should be on high volume or high value product destined for export markets. Following that focus should move to lower volume and low value products with more focus on the domestic markets.

Trade and market access research.

The Seafood CRC built considerable capability in trade and market access research to the benefit of the seafood industry. Maintaining this capability in the short term (post the ASCRC) is a priority issue, both in terms of enabling on-going access to markets and resolving food safety related trade issues, but also in terms of maintaining capability for incident management and for dealing with emerging issues in a cost effective manner. Much of trade and market access research saves money through avoidance of issues and therefore a base program needs to exist to track emerging risks and international regulations. For example, SafeFish has successfully argued during international food standards development at the Codex Alimentarius Commission against mandatory testing for vibrios and viruses in shellfish, and marine biotoxins in abalone, saving the Australian industry millions of dollars in unnecessary testing.

In the medium term, focus should be given to defining and improving the nutritional benefits of seafood. Consumers and governments are becoming more aware of the nutritional benefits of their food sources, and the seafood industry should be promoting the benefits of seafood consumption, including investing in the development of functional foods and foods targeting specific populations. Internationally risk analysis is trending towards risk/benefit analysis for effective public health outcomes requiring improved knowledge on the benefits conferred from seafood.

f. Realisation

Improving capability for screening techniques for rapid, sensitive, cheap, reliable detection of pathogens and contaminants in the food industry

Work in the area of novel diagnostic platform development is growing nationally, with many institutions able to undertake components of the work. Research in this field, however, is still fragmented with groups working on a variety of diagnostic issues and platforms independently. The biosensing capability within Australia still needs to mature with experts coming together who have knowledge in developing appropriate biological receptors and those able to develop new sensing platforms.

Further impediment to this kind of research is the expense required to develop and validate novel diagnostic technologies.

Quality and value-add

As discussed above, access to suitable research capacity to assist in innovation projects can be an issue for some seafood producers. Formal collaborative research networks or centres would provide easily accessible research capacity that could result in increased innovation in the seafood industry and lead to greater profitability in the sector in the longer term.

There is an inadequate understanding on the prevalence of some pathogenic bacteria (e.g. *Clostridium botulinum*) in the marine environment and the interactions and impact of multiple hurdle technologies. Whilst microbiological challenge tests are a useful tool in determining the ability of a food to support the growth of spoilage or pathogenic organisms, they are expensive. Cheaper diagnostics could help overcome validation costs. New products should be developed safely as they may present new product/hazard combinations.

Marine biotoxins

Laboratory diagnostics are expensive and often cost prohibitive. Limited capability and capacity for analysis exists in Australia, particularly in the research arena. A national marine biotoxin research facility that could operate at reduced costs would allow more cost-effective research projects, provide training for scientists entering the field and attract international collaborators.

A national facility would also promote the collaborations between industry, researchers and regulators across all states. These collaborations are necessary to prioritise and drive the research needed to address this issue at a national level (previous market failures have often been the result of individual states attempting to address issues independently). The emergence of the Australian Marine Biotoxin Partnership between industry, regulators and researchers to address the lack of national testing facilities for marine biotoxins, showed that when the states combined and addressed the issue as a national issue, positive outcomes could be achieved. A national facility could ensure development and long-term survival of this partnership.

Trade and market access research

The current SafeFish model has proven successful in bringing together experts in foods safety and hygiene to work together with industry and regulators on agreed high priority issues, however this model needs to be adapted to continue post ASCRC. Base capability to track and prioritise emerging issues before they close markets is imperative.

SafeFish promotes research in key areas, but has a limited budget to undertake research. The recent removal of FRDC tactical research funds results in a paucity of funding bodies for the type of rapid, responsive research required to address technical trade disputes. The long lead up times in the current funding arrangements are not suitable for incident response requirements on the domestic or export level.

National capability in trade and market access research should be funded by the entire seafood industry, as all are beneficiaries. The maintenance of a strong Australian reputation for seafood safety has a positive impact on all seafood markets, and any negative seafood safety incidents have repercussions for all as well. The fragmented nature of the seafood industry and the lack of a single national representative body hampers efforts in this regard.

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