

Australian Abalone Growers Association, (AAGA): Management of R&D Portfolio

Industry Partnership Agreement

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FRDC Project No 2016-415

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Abbreviations

AAGA	Australian Abalone Growers Association
ACA	Abalone Council of Australia
AVG	Abalone Viral Ganglioneuritis
a-EADRA	Aquatic Emergency Animal Disease Response Agreement
DPIPWE	Department of Primary Industries, Water and Environment (Tas)
DPIRD	Department of Primary Industries and Regional Development (WA)
FRDC	Fisheries Research and Development Corporation
IPA	Industry Partnership Agreement
IRA	Import Risk Assessment
PIRSA	Department of Primary Industries and Regions, South Australia
SARDI	South Australian Research and Development Institute
VFA	Victorian Fisheries Authority

Executive Summary

This report describes the outcomes from a five-year Industry Partnership Agreement (IPA) between Fisheries Research and Development Corporation (FRDC) and the Australian Abalone Gowers Association (AAGA). The project was led by AAGA Executive Officer, Nicholas Savva with assistance from members of the AAGA management committee. The primary objective of the IPA was to coordinate R&D related to abalone farming funded through FRDC and other sources. To ensure involvement of members in the development and running of that R&D. And extension to members for uptake of research outcomes.

During the five years 15 abalone and related R&D projects were conducted with \$853,000 contributed via the IPA and considerably more from research institutions and in kind from farms and other participants including feed manufacturers. Projects supported by the IPA were consistent with the priorities in the AAGA Strategic Plan 2015-2020. Ten of the 15 projects are now complete, or near completion. All the projects have delivered benefits to the industry.

Nutrition has long been and will continue to be a focus for AAGA R&D.

Knowledge of abalone genetics including the genetic pool on farms and the nature of abalone responses to AVG and to higher summer water temperatures will aid selective breeding.

Improvements to biosecurity and vigilant surveillance has resulted in robust on farm biosecurity plans and no disease outbreaks on farms.

During this project AAGA developed a new strategic plan that will guide research in a new IPA to cover the period from 2020 – 2025 was completed. Significant outcomes from the new Strategic Plan include:

- The need for stronger links between nutrition and genetic selection especially in response to warming waters.
- The need to develop and embrace AI and mechanisation to improve labour efficiencies and invest in our labour force to provide improved quality employment opportunities.
- Recognition that additional funding for R&D will need to be sourced.

Keywords

Abalone, Haliotis rubra, Haliotis laevigata, Haliotis laevigata x Haliotis rubra, Hybrid, Strategic Plan

Introduction

The Australian Abalone Growers Association (AAGA) has a long history of working with the FRDC. AAGA developed the AAGA Strategic Plan 2015-2020 in consultation with members (28th May 2015) and a subsequent Industry Partnership Agreement (IPA) with FRDC. This was consistent with FRDC's policy devolving responsibility for strategic priorities and direction to industry by providing funds through IPA's.

This project was developed to plan and manage AAGA's RD&E portfolio in partnership with FRDC to ensure that research continued to provide results that addressed key priority areas of the industry. Specifically, the functions needed to achieve this were:

- a. Develop collaborations with R&D agencies to assist development of RD&E projects needed to address issues described in the AAGA Strategic Plan 2015-2020, including:
 - sustainable development of the industry;
 - maintaining and enhancing biosecurity and abalone health;
 - an emphasis on abalone health via nutrition;
 - increases in production efficiency and profitability;
 - enhanced development of markets for quality abalone products; and
 - improved human capacity, safety and training
- b. Ensure effective and rapid dissemination, extension, and uptake of the outcomes of R&D to AAGA members
- c. Identify alternative sources of funding that can be accessed through co-investment in additional RD&E projects to achieve greater outcomes for the farmed abalone industry.

Objectives

This project addressed the following six main objectives:

- 1. Coordinate development of RD&E projects in line with AAGA/FRDC IPA.
- 2. Publish annual industry reports and distribute to AAGA members
- 3. Manage communications with AAGA members.
- 4. Organise annual industry workshops and other special topic workshops as required.
- 5. Review and update the AAGA RD&E strategic plan.
- 6. Promote the industry's viability and sustainability and social licence to operate.

Methods

The AAGA Executive Officer (EO, Nick Savva) led the project with assistance from the AAGA Management Committee that identified and participated in development of RD&E projects that were prepared in collaboration with the most appropriate research providers. Project applications were subsequently submitted through FishNet for FRDC consideration in line with the AAGA/FRDC IPA. The project included organising and chairing quarterly (and as required) Management Committee meetings that included FRDC representation.

Managed communications with AAGA members and ensure effective integration of RD&E projects. Throughout the project the EO managed AAG RD&E through the following activities:

Published annual industry reports and distributed to members, (2016,2017,2018,2019). 2020

- report due at next AGM, Aug/Sep 2020.
 Ran annual industry workshops (Sep 2016, Aug 2017, Aug 2018, Aug 2019) 2020 due Aug/Sep 2020.
- Chaired Annual General Meetings including budget presentations.
- Chaired regular Management Committee meetings.
- Chaired other special topic workshops as required to bring together farmers and researchers, including:
 - Special Nutrition Workshop (Deakin) 13/12/16, Melbourne.
 - AAGA Biosecurity Workshop, 9/9/16.
 - Nutrition RD&E steering Committee meeting, 6/6/2017.
 - Nutrition R&D Meeting Deakin, Melbourne, 10/5/19.
 - Nutrition Meeting FRDC Adelaide. 24/9/19.
- Attended
 - FRDC National Contributions workshop Melbourne 15/2/2017.
 - FRDC Annual Stakeholder planning Workshops, 2016, 2017, 2018, 2019.
 - CSIRO Seaweed Workshop, Hobart 1/11/19.
- Presented
 - Aquatic Animal Health Technical Forum, 14~16/2/2018 <u>Safe stock translocations</u> <u>between abalone farms.</u>
 - ACA/AAGA workshop. 14/11/2019. <u>Opportunities for improved relationships</u> between fishers and farmers for mutual benefit.
 - ACA Abalone Convention, 30~31/7/19. <u>Abalone Stock Enhancement A Farmers</u> <u>Perspective.</u>

Review and update the AAGA RD&E strategic plan including budgeting and funding opportunities in response to emerging opportunities and threats.

In consultation with FRDC, the EO maintained oversight of the AAGA IPA budget that was included in annual reports to members. This included consideration of allocation of budgets for new proposals and projects.

Promote the industry's viability and sustainability and social licence to operate.

Australian Wooden Boat Festival 8-11/2/2019. At this event members organised an Abalone Master Class including presentation of abalone farming and a cooking demonstration with Eloise Emmet.

To improve social licence, AAGA have progress development of an industry scorecard including descriptive infographics to inform the public of the benfits provided by this industry and

commitments to sustainability a support for regional economies. To progress this initiative AAGA a Sub-committee was formed (28/5/2020) and a draft infographic prepared from supporting data is under development.

Manage and review the IPA with FRDC.

The EO arranged and chaired a Strategic Planning and Constitution Revision Meeting, Albert Park, Melbourne 14/2/20 and subsequent Zoom meetings. These meetings identified RD&E priorities and have resulted in completion of the next AAGA strategic plan 2020-2025 (Appendix 1). The IPA has been discussed with FRDC that have committed to maintain the intent of the current agreement while the new FRDC R&D Plan is completed and implementation has begun.

Ensure representation of AAGA at International Abalone Symposium, (IAS) Xiamen, China 2018.

To maintain oversight of developments in global abalone farming, the EO presented on Australian Farm Production at the International Abalone Symposium, (IAS) Xiamen, China 2018. The EO provided a presentation of findings from this symposium to members at the subsequent annual abalone farming industry workshop at Queenscliff, Victoria.

Results, Discussion and Conclusions

Summary of outcomes from FRDC/AAGA IPA projects.

2015-231: AAGA IPA: Obtaining approvals for abalone relaxants (\$43,572).

Handling abalone is often difficult because they adhere strongly to available substrates and are consequently difficult to remove from culture tanks. Relaxants (products that decrease muscle tone and the ability of the abalone to grip the substrate) are used in abalone aquaculture to facilitate handling during harvesting, grading and when stocking density changes are required during farming. The use of relaxants improves health and welfare of farmed abalone through minimising injury, immune suppression and mortality associated with handling. This study aimed to collate existing data and address gaps to obtain minor use permits (MUPs) from the Australian pesticides and Veterinary Medicines Authority (APVMA) for magnesium chloride (MgCl₂) and 2-phenoxyethanol (2-PE), and to obtain data for magnesium sulphate (MgSO₄). MUPs facilitate legal use of reliable, safe products for abalone in the Australian aquaculture industry.

This study obtained data to complete the environmental risk assessment and APVMA Environment Module for MgCl₂ and 2-PE and compiled chemistry and manufacture, toxicology, residues, workplace health and safety, environment, efficacy and target animal safety data for MgSO₄. These data were compiled and MUP applications were completed and submitted to APVMA. Permits were obtained for 2-PE (PER83233), MgCl₂ (PER83238) and MgSO₄ (PER86963). These permits facilitate improved industry husbandry and harvest practices with decreased mortality, stress and loss of performance and contribute to improved abalone health.

The use of magnesium salts is expected to promote further investment in mechanisation of handling and grading.

2016-009: Aquatic Animal Health and Biosecurity Subprogram (AAHBS): *Perkinsus olseni* in abalone – development of fit-for-purpose tools to support its management (Total project \$139,908. AAGA - \$20,007).

AAGA provided co-investment for this project. The final report has been submitted to AAHBS for evaluation.

To date *Perkinsus* is not considered a significant management issue for Australian farms beyond possible trade issues with sub-clinical infections. *Perkinsus olseni* is listed internationally as a notifiable disease by the World Organisation for Animal Health (OIE). It has been reported in several mollusc species in NSW, Victoria, South Australia (SA), and WA and is to date the only species of *Perkinsus* infecting abalone in Australia. Consequently, *Perkinsus* present in commercially important molluscs, including abalone in Australia, can represent a barrier to international trade. The ability to detect this parasite quickly is critical for both the abalone industry and government agencies. However, tests for *Perkinsus*, are time consuming and laborious and infections are difficult to detect with certainty at sub-clinical levels. False positives appear to be common.

The project was able to successfully propagate a new *P. olseni* isolate from Queensland and successfully cultured the isolates from Spain, Japan, New Zealand, and South Australia as well as *P. chesapeaki*. The first step in developing a new immunological diagnostic test is to develop an antibody able to bind to the abalone parasite *P. olseni*, so a test could be developed in the future.

The project produced several antibodies specific for *P. olseni*, including different life stages of the parasite.

A complete reference genome for *P. olseni* from South Australia was generated as well as other *P. olseni* genomes for different geographical isolates and for *P. chesapeaki* from Queensland. This was the first time that the genomes of these two parasites were sequenced and they will provide invaluable insights into the physiology and origin of this parasite; and boost studies investigating host/parasite interactions and pathogenicity.

The abalone industry will directly and indirectly benefit from the tools and information that have been generated by this project, which constitute the foundation for further work in order to enhance industry preparedness to *P. olseni* outbreaks. Indeed, further studies could

- (1) develop a qPCR test able to quantify an infection;
- (2) develop an antibody-based test, which would improve early detection of P. olseni on farm; and
- (3) understand the mechanics behind an infection using transcriptomics, which would be invaluable to identify risk factors associated with disease development or producing *P. olseni* resistant abalone spat as part of a selective breeding program.

2016-142: Genetic Diversity audit of farm held stocks of Greenlip and Blacklip abalone (\$35,205).

Project complete. This project conducted by Jan Strugnell, James Cook University, provided valuable insights into differences between stocks in different regions and on different farms and revealed opportunities for farms to outbreed stocks for greater resilience and avoid inbreeding.

Pairwise comparisons of all farms found levels of genetic differentiation between farms to be moderate to great, for each species. Several farms were found to have genetically distinct broodstock. Genetic diversity was found to be relatively low in blacklips across farms and in comparsion to a prior study of wild populations. In addition there was some evidence of inbreeding in greenlips across farms. Although difficult to measure, several estimates suggest that effective population size is low across several farms. A mate allocation plan developed indicates that sharing genetic resources across farms would be the best strategy in order to minimise kinship for both greenlip and blacklip abalone.

Implications from this project for abalone growers include that current bans on moving abalone across state borders is preventing abalone farmers from maximising the use of their genetic resources in order to minimise kinship. Unfortunately this is of limited value for Tasmanian farms due to DPIPWE's ongoing policy to prevent translocation of domesticated disease-free abalone from mainland farms into Tasmania, despite approval from (Tasmania) CVO following an exhaustive IRA (Import Risk Assessment). A nationwide breeding strategy continues to be an objective of AAGA to improve production and resilience in the face of climate change.

The project provided the following recommendations.

- (1) Translocating broodstock between farms (which in many cases reflect state boundaries) would be beneficial in order for farms with genetically divergent abalone stocks to share genetic resources to minimise kinship, maximise genetic diversity and prevent further inbreeding.
- (2) Any new broodstock that is introduced should be genotyped in order to assess genetic differentiation in comparison to existing stock.

- (3) Effective population size should be increased in several farms to avoid the negative effects of inbreeding in future generations.
- (4) Consider assessing genetic diversity levels of wild populations to serve as a baseline for aquaculture stocks and potentially bring in wild animals for improvement of genetic diversity of captive populations, particularly for blacklips.
- (5) Consider taking advantage of these established genetic resources to aid future selection efforts for traits of interest

2016-245: Development of sector-specific biosecurity plan templates and guidance documents for the abalone and oyster aquaculture industries (Total project \$60,000. AAGA - \$9,995).

AAGA provided co-investment for this project. This project has been completed and the report can be accessed from DAWE website. The project developed abalone farm specific templates and promoted an improved awareness and upgrading of on-farm biosecurity plans.

See - (<u>https://www.agriculture.gov.au/sites/default/files/sitecollectiondocuments/animal-plant/aquatic/abalone.pdf</u>).

2016-415: Management of Australian Abalone Growers Associations RD&E portfolio (\$160,000).

This project report.

2017-113: Elucidating the nutritional requirements of farmed hybrid abalone (\$282,544).

Project overview:

This project set out to achieve four key objectives towards advancing knowledge on the nutritional requirements of farmed hybrid abalone and improving on-farm performance during inclement environmental conditions:

- 1. To elucidate the key nutritional requirements of farmed hybrid abalone (Haliotis laevigata x rubra) with respect to stage of growth and environmental rearing temperature.
- 2. Profile the nutritional characteristics of commercially available abalone aquafeeds towards improved hybrid abalone feed formulations.
- 3. Understand the impacts of nutritional conditioning on the survival of abalone in response to adverse temperature conditions.
- 4. Development of rapid screening assays for diet digestibility and on-farm performance assessment.

This was accomplished via the execution of two long-term feeding trials investigating the performance and survival of hybrid abalone fed five graded levels of dietary protein across three temperature regimes established to replicate winter (12°C), summer (22°C) and optimal rearing conditions (17°C) in juvenile and sub-adult cohorts.

Key findings:

The feeding trials ran as planned and all experimental diets were well received across the experiments. Whilst an optimal dietary protein level was not evident in the sub-adult cohort at 22°C, animals in the 12°C and 17°C experiments demonstrated improved growth performance when the dietary protein inclusion level was in excess of 38%. This finding was later verified in the juvenile cohort, where a dietary protein inclusion level of 41% resulted in significantly improved growth performance at 17°C and 22°C experiments compared to animals fed the industry standard of 35%. As such, this data suggests that there are considerable benefits of feeding a higher dietary protein level when at a time of year when water temperature conditions are conducive to animal growth (e.g. >17°C). However, given the reduced metabolic rate of animal during the winter months, little benefit would be realised by feeding diets formulated above the current industry standard with respect to protein.

Abalone cultured at 22°C were exposed to simulated summer temperature stress events, during which water temperatures were elevated to 26°C in the sub-adult cohort and 28°C in the juvenile cohort for 5 and 7 days, respectively. No trend in the number or pace of mortalities was evident amongst the protein treatments for either age cohort. This suggests that temperature stress experienced by hybrid abalone during summer heatwaves is unaffected by the dietary protein levels within the scope tested in this project.

Current status:

All experimentation has now been completed and the final report for 2017-113 is being drafted. COVID-19 resulted in significant delays, largely revolving and site access issues generated by lengthy lockdowns. As a result, the data associated with gene expression analysis is outstanding but analysis is now underway.

2017-117: Aquatic Animal Health and Biosecurity Subprogram: Identification of differentially expressed innate immune genes in the New Zealand paua (*Haliotis iris*) and the Australian hybrid abalone (*H. laevigata* x *H. rubra*) upon immersion challenge with the abalone herpesvirus-1 (HaHV). (Total project - \$121,127. AAGA - \$7,086)

Project complete.

The project aimed to identify whether differential innate immune gene expression exists between the abalone viral ganglioneuritis (AVG) resistant päua and the AVG susceptible hybrid abalone after being exposed to the disease causing agent Haliotid herpesvirus-1 (HaHV-1).

Preliminary testing using the immune genes viperin and IRF-1 as targets allowed identification of favourable tissues and time points after challenge to perform RNA sequencing on genes expressed in both species.

The transcriptome profiling of the two abalone species was performed against both a dsRNA viral mimic to assess what a normal response to a viral infection would look like in the absence of viral antagonism in each abalone species, as well as following HaHV-1 viral challenge. The overarching result of the RNA sequencing was that the early anti-viral response of the two abalone species is very different to both a synthetic viral mimic as well as HaHV-1.

The päua abalone appears to have a strong transcriptional response linked to matrix remodelling in the haemocytes following both stimulation with a viral mimic, as well as following challenge with HaHV-1. This response appears to be absent in the haemocytes of the hybrid abalone, however

there was some indication that a matrix remodelling response may be occurring in the gill transcriptome at a later time point, potentially adding weight to the hypothesis that the hybrid abalone may have a more delayed anti-viral response. It should however also be noted that many differentially regulated transcripts could not be identified in both species of abalone, and this is most likely due to the novel nature of the abalone genomes, and the lack of information and research surrounding analysis of gene function in most marine organisms.

Collectively the work from this project has optimised real-time PCR in an abalone species, and across abalone species for the first time. It has demonstrated that two abalone species can have a very divergent transcriptional response to a viral pathogen; and that the HaHV-1 resistant pau abalone has a heightened transcriptional response that demonstrates an upregulation of genes involved in remodelling of matrix, which appears to be absent in the hybrid abalone at similar time points.

Implications and further development

AVG remains a serious concern to all State jurisdictions with significant commercial investments in abalone fisheries and aquaculture. Data obtained from this project provides the basic knowledge on the mechanisms of resistance to AVG including insight for the first time into the anti-viral transcriptome response of a HaHV-1 resistant abalone species, and allows us to begin to determine which pathways and/or genes may be involved in a successful host abalone response to viral infection.

Future work could focus on determining the genes responsible for specific protection against AVG. In order to demonstrate which genes have a major functionality in the protective mechanisms, the silencing (or knock down of expression) of each one individually, and/or many in combination, would confirm the presumptive role of these genes highlighted in this current genomic study. The RNAi technology, widely used in various species including abalone, has proven effective in silencing/knocking down gene expression and demonstrating their function in animal and plant species. The application of such technology could provide the information on selected genes in the päua with regards to AVG resistance. Multiple avenues could then be taken to attempt to facilitate a similar response in the Australian hybrid abalone, including:

- (1) determining the ability of Australian hybrid abalone to upregulate these genes in response to certain stimuli to develop a 'vaccine like' strategy;
- (2) developing a high through-put screening system to screen Australian hybrid abalone for a 'HaHV-1 resistant-like profile, and initiate breeding programs based on this knowledge; or
- (3) exploring gene knock-in using CRISPR/cas technology that has been performed successfully in fish, but is a long-term prospect.

Recommendations

Numerous further studies could be implemented from the data presented within this report including:

(1) The early up-regulation of the matrix remodelling gene and collagen genes in the päua upon poly-I:C injection as well as viral challenge and the absence or delayed up-regulation in the hybrid abalone is suggestive of their involvement in the protection against AVG. In order to confirm this hypothesis it would be beneficial to perform further studies using cutting edge technologies such as gene editing or RNA interference to eliminate or reduce the function of these genes in vivo and proceed to a live challenge of päua 'deprived' of these genes. If the importance of the matrix remodelling and collagen genes was confirmed, such families of genes could be targeted in a breeding program for AVG resistance.

- (2) There is now published genomes for both the hybrid and päua abalone; and this project has generated de novo transcriptomes for both genomes for the first time. Both genomes should be screened for the presence of presumed essential and known viral pattern recognition receptors, and potential known signalling adaptor proteins, to ensure that the hybrid and päua abalone species have a similar complement of known anti-viral signalling molecules. Major differences may point to potential targets for breeding programs, as well genetic engineering opportunities of the hybrid abalone.
- (3) The päua abalone response to a synthetic viral mimic is now known, and a similar response in the hybrid abalone could now be therapeutically sought as a priming protective strategy to protect Australian abalone against HaHV-1.

2017-220: Testing established methods of early prediction of genetic merit in abalone broodstock (\$85,422).

Project continuing.

The objective of this project is to assess the utility of RNA/DNA ratio as a method for early prediction of high performing abalone broodstock. The project requires that assessments of young abalone are compared against data collected when these abalone achieve market size (more than 2 years old).

Young abalone were sampled as soon as they settled and were then genotyped to determine their parentage and levels of absolute RNA and DNA measured in order to calculate their individual RNA/DNA ratio. Final sample collections are due to be collected in January 2021. With analysis and reporting to follow.

2018-004: Safefish 2018-2021 (AAGA - \$14,963. Approx. \$5,000pa).

Contribution from AAGA to communal seafood industry project that conducts research and informs on food safety and market access issues.

2018-057: Population genomic assessment of Australian blacklip abalone for abalone viral ganglioneuritis (AVG) resistance (Total project - \$156,769. AAGA - \$47,031).

A co-operative project with the wild abalone sector and strong endorsement from VFA. Project near completion. Minor delays due to COVID-19.

Despite AVG not being recorded in Victoria waters since 2010, it still remains the greatest threat to the economic viability of the abalone industry in south-eastern Australia. This project seeks to determine if genetic resistance to the AVG virus persists in the Australian wild blacklip abalone fisheries. This project will contrast the genetic profiles of multiple AVG affected and unaffected fishing stocks from Victorian abalone fisheries, to test for the occurrence of genetic markers unique to AVG affected stocks and indicative of virus resistance. Genomic variants associated with AVG resistance will act as the necessary markers for surveying the virus resilience/vulnerability of wild fishing stocks, and biosecuring wild fishing and farm stocks by providing a basis for a future virus resistance breeding program.

2018-128: Seafood Trade Advisory Group – developing implementing and communicating the Australian seafood industry trade agenda 2019-2021 (\$32,444).

Contribution from AAGA to communal Australian seafood industry project.

2018-180: Benchmarking for health and productivity in aquaculture (Total project \$108,620. AAGA - \$4,519).

Delayed due to COVID-19 restrictions and consequent redeployment of Principal Investigator.

Industry benchmarking for animal health and production characteristics is commonly practiced in many intensive agricultural industries. Benchmarking provides the ability of farms within an industry to compare their individual farm data against an industry median (or other desired standards) and then take remedial action where it is shown that improvements should be considered. This pilot project aims to increase farm productivity and aid in the prevention and/or early detection of new and production issues through robust data collection and benchmarking on abalone farms.

2019-147: Risk factors and management strategies associated with summer mortality in Australian abalone (\$92,308).

Delayed due to moderate summer water temperatures in Victoria 2020 and COVID-19.

Climate change driven higher summer seawater temperatures and consequent susceptibility to summer mortality is of great concern for abalone farms. When water temperatures exceed 22°C high levels of mortality have been reported for cultured greenlip abalone as well as wild abalone. High mortality during warm summer water temperatures has been termed "summer mortality" by Australian abalone growers and researchers. Summer mortality is not a well-defined condition. Mortalities also seem to be associated with a number of abiotic and biotic factors and to date notifiable and infectious disease agents have been ruled out, although this information has not been summarised and documented.

Project aims:

- 1. Summarise current abalone health and summer mortality research
- 2. Develop a case definition for summer mortality
- 3. Summarise retrospective mortality investigations and laboratory submissions for Australian abalone
- 4. Investigate summer mortality events during the life of the project to comprehensively rule out primary pathogens and infectious agents, in both control and impacted abalone populations.

2019-151: Application of a machine learning approach to stock management of farmed abalone (\$115,649).

Delayed commencement due to COVID-19.

This project would involve the development, training and validation of a machine learning model to identify, segment and measure quantitative abalone traits in production systems and, render the product data to be accessible and applicable for farmers.

2019-156: The use of dietary intervention with Ulva to improve survival associated with the incidence of summer mortality on farmed abalone (\$175,249).

Near completion. Some delays due to COVID-19 and deliberate extending of sampling later into summer than initially planned.

The objective of this project is to use dietary intervention using dried Ulva meal to ameliorate the effects of summer mortality on the survival of greenlip abalone (*H. laevigata*) and tiger/hybrid abalone (*H. laevigata* × *H. rubra*) cultured under commercial conditions during the summer production cycle.

2019-204: AAGA Strategic R&D Plan 2020-2025 (\$25,422).

Completed July 2020. Appendix 1.

Summary of outcomes from other projects and activities.

"Thriving Abalone" project within the SARDI Functional Food Focus Program (PIRSA Agribusiness Accelerator Program). The project investigated the incorporation of micro- and macro-ingredients derived from a range of food waste products into aquafeeds for abalone to improve growth performance, health and product quality. This Included trials adding novel and waste stream ingredients to abalone diets.

Results included:

- Grape Seed Extract addition at 5% increased survivability of abalone at high temperatures in laboratory trials.
- Fresh Ulva as control diet for abalone survival at high temperatures.
- Addition of dried seaweeds to diets with promising results e.g. *Gracilaria* with high protein content

Whilst laboratory trials were often successful this success did not necessarily translate into improved results on farm; in part due to consistency of quality and supply of commercial quantities. AAGA members retain interest in the use of seaweeds within feeds, especially for addressing summer mortality, broodstock conditioning and early weaning purposes.

Publications from this project

Stone, D.A.J., Bansemer, M.S., Currie, K-L., Saunders, L., Harris, J.O., (2016). Increased dietary protein improves the commercial production of hybrid abalone (Haliotis laevigata × Haliotis rubra). Journal of Shellfish Research.

Matthew S. Bansemer, Jian Qin, James O. Harris, Duong N. Duong, Krishna-Lee Currie, Gordon S. Howarth and David A.J. Stone (2016). Dietary inclusions of dried macroalgae meal in formulated diets improve the growth of greenlip abalone (Haliotis laevigata). Journal of Applied Phycology. DOI: 10.1007/s10811-016-0829-0

Stone, D.A.J., Bansemer, M.S., Lange, B., Schaefer, E.N., Howarth, G.S., Harris, J.O., (2014). Dietary intervention improves the survival of cultured greenlip abalone (Haliotis laevigata Donovan) at high water temperatures. Aquaculture 430, 230-240.

The Aquatic Emergency Animal Disease Response Agreement (Aquatic Deed) - aEADRA.

The Commonwealth Government (DAWE) initiated a project to put in place an agreement dealing with management of the response to aquatic disease emergencies, similar to the agreements with other primary industries. These agreements set out in advance how the response would be managed (including industry representation), agreed budget and who pays; and how farms will be compensated. Negotiations to establish the a-EADRA have been ongoing for many years with AAGA representing our industry at many meetings presenting a significant drain on AAGA resources. Unfortunately, the effort in developing the draft is likely to be wasted as it appears that a final Aquatic Deed will not be realised and consequently AAGA has withdrawn from further consultation. A strong positive benefit from the Deed process was recognition of the need for, and implementation of, stronger on-farm biosecurity plans.

The National Aquaculture Council (NAC)

The NAC represents aquaculture industries on issues of national coverage but is currently in a period of transition with a review of its management underway. AAGA has been a strong supporter of NAC but is currently not a member. Unfortunately following a recently completed review, the Directors have decided to wind up NAC and are exploring other options for effective aquaculture industry representation.

Governance & Constitution

The AAGA constitution and governance structures created in June 2004 were no longer fit for purpose, largely as a product of the growth of our industry (below). The AAGA Committee is well advanced in re-drafting the constitution and improving governance structures. Changes are expected to be adopted at the next AGM August/September 2020.

Industry Growth

Farmed abalone production has grown considerably since 2000. (Fig. 1) Growth since 2015 has continued but at a slower rate than AAGA predictions. Further investments in management strategies, the size of existing farms and planned new developments is expected to result in further growth. Trade conditions because of overseas expansions of abalone farms, (especially in China) and responses to COVID-19 have increased supply, diminished demand and limited access to markets. Growth of our sector may be dampened in the near future; thus growth predications were revised downward from June 2020. Production in the financial year ending June 2020 was less than expected due to many farms holding off harvesting stock in response to the poor market conditions resulting from COVID-19.



Fig. 1: Australian Farmed Abalone Production. Actual and Projected.

Recommendations

Further development

Continuation of an AAGA Management project is necessary to ensure best planning and outcomes from current and future R&D projects and is outlined in the AAGA Strategic Plan 2020-2025. (July 2020).

The new AAGA Strategic Plan 2020-2025 (July 2020) recognises the need for greater funding and targeting of R&D ahead of developing a new IPA with FRDC.

In the near future the following actions promoted through this project will be completed

- The new Strategic Plan approved by AAGA management committee.
- A new IPA with FRDC will be finalised.

Extension and Adoption

Project reports are available to AAGA members via the AAGA dropbox. A dedicated AAGA website with member links is under consideration. Such a website may also promote our credentials to government agencies and the broader community.

Extension and adoption were integral to the project. Outcomes from R&D projects have been adopted, in some cases prior to results being published. For example:

- Higher protein diets adopted by feed manufacturers.
- Improved biosecurity plans and practices.
- Use of 2-phenoxyethanol and magnesium salts as relaxants.
- Exchange of genetically improved stocks between farms.

Project materials developed

Final reports from each of the research projects is available from the FRDC website <u>http://www.frdc.com.au/research/final-reports</u>

Appendices

APPENDIX 1: AAGA Strategic R&D Plan 2020-2025

STRATEGIC PLAN 2020-2025





Australian Abalone Growers Association PO Box 216 Beaconsfield TASMANIA 7270

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Foreword

Aquaculture is the world's fastest growing primary industry.

Abalone farming in Australia has established its reputation as a viable producer of farmed abalone of exceptional and consistent quality.

Premium quality is central to our industry. Market demand for our product is strong with farm gate prices reflecting the premium quality of our products in international markets, being ranked 1st or 2nd on a per kg basis.

We plan to grow our industry in volume and value through increased focus on sustainable farming of high-quality abalone for niche customers. Our farms expect to double sector production over the next 5 year planning horizon to 2025. Note that this document was drafted during the coronavirus pandemic and related market uncertainty.

Consolidation of our industry over the last five years has resulted in improved economies of scale on farms, and an increasing adoption of technologies and practices that are boosting production efficiency and product quality. Furthermore, this growth will ensure that our industry continues to stimulate local rural communities and economies whilst providing more and better-quality employment opportunities.

To achieve this growth, we need to attract further investment, better understand our key threats, overcome some regulatory barriers, and invest further in research and development to ensure improvements to production efficiency and the continued safety, quality and integrity of the abalone we produce. AAGA will continue its central roles to convene strategic thinking, advocate on behalf of our industry to government and the broader community, and coordinate our research and development activities.

This Plan summarises our strategic goals, aspirations and plans at May 2020 and the outcomes we aim to achieve by June 2025. The Plan is designed to provide guidance whilst allowing agility for the AAGA board and its Members to assess and prioritise future themes and projects, and related investments. The design also



enables reporting of progress against the Plan, to Members and external stakeholders. It became apparent during the drafting of this plan that additional funding will be required to meet the breadth of R&D objectives described herein.

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- Fisheries Research and Development Corporation (FRDC) for funding,
- Australian Abalone Growers Association Members for input,
- Ridge Partners for contribution to the development of the Plan.



1. STRATEGY FRAMEWORK

Vision and Mission

Australia's abalone farmers produce high quality products for local and global markets. Collectively these farmers contribute (subject to coronavirus impacts) about 1,100 tonnes to a global abalone supply of ~139,000 tonnes (wild catch 6,400 and aquaculture 132,000 tonnes; FAO 2017).

As a niche supplier Australian farms face significant challenges and opportunities over the coming decade to 2030. But by working and investing together the farms intend to build on their initial 2015-20 Plan, to consolidate and improve their position for 2020-25 and over the long term.

Members of AAGA represent >95% of Australian farmed abalone production. In early 2020 the association engaged all farmers, investors and key stakeholders to review their sector performance over the past five years, and to guide this Plan based on enterprise and sector aspirations, trends and strategic options to 2025. The coronavirus pandemic was underway during the Plan's development.

Members considered the key strategic issues, risks and goals for farmed products in global and domestic markets, the priorities for creating and preserving value along the chain from hatchery to market, and the expectations of investors and the community regarding the performance of businesses in the aquatic environment. Members identified their organisational Vision, Mission and Values for the coming decade.

This Plan draws these strategic themes, priorities and actions together in a document that AAGA will implement on Members' behalf. The Plan also provides Members with a united platform to leverage their RD&E investment via a new Industry Partnership Agreement (IPA) with the FRDC.

AAGA Mission

AAGA will lead and support its members to farm the world's best abalone, sustainably and viably.

Values

Nutritious, attractive and safe seafood

Safe, healthy and fullfilling workplaces

Viable and united abalone businesses

Collaboration and trust with our members, the wildcatch sector and our communities

Sound management of our businesses and sector

Vision 2025

Australian Abalone is preferred across world markets. Our farmed abalone will:

Be recognised and sought after by Global Markets

Be grown in and harvested from Sustainable Farming Systems

Be produced by farms whose Return on Investment (ROI) will be in the top quartile of all Australian Aquaculture producers.

Strategic Goals 2025 Innovative Farms National genetic development Better nutrition Healthy, biosecure animals Sustainable farms Adequate human capacity Effective precompetitive marketing Efficient Governance

Drivers and Risks

Global Trends and Risks

- Good quality farmed products from South Korea and South African are significant competitors for Australian farms
- Some farm capacity in China is not viable but China will remain the dominant market and producer
- Productivity driven by innovation technologies, breeding, supply chains
- Markets seek rewarding sustainable farm systems
- Increased risk of uncontrolled global human and animal disease – e.g. swine fever, coronavirus
- Climate change will be a risk to all farms driven by storm damage, increased water temperature and greater disease risks.

Australian Trends and Risks

- AAGA growth aspirations from 2015 were moderated by investor consolidation, red tape on farms, environmental compliance, fire, and disease events
- Australian wildcatch volume still declining
- Uncertainty / decline in the Australian wildcatch abalone fishery may impact AAGA
- Increased downward price pressure due to global oversupply
- Australian farms can only farm local species (Greenlip and hybrids) – due to strict biosecurity. China has (genetically enhanced) traditional and imported spp.
- Reduced demand (domestic and export) due to impacts from COVID-19.



Australian Farmed Abalone Industry - SWOT & Competitive Advantage

Add input suppliers to an "Affiliated Member" category in Constitution **OPPORTUNITIES**

STRENGTHS	WEAKNESSES
Australia's leadership position in global abalone markets	Lack of economic scale in global abalone farming increases unit costs
Australia's good reputation in global markets - desirable species; clean water	Limited use of modern aquafarm technologies
farming; reputation for safe, sustainable and attractive seafood	Labour: very high labour costs and poor quality jobs
Farmed abalone industry restructure has increased farm management capacity while spreading geographic site risks	High energy costs relative to production
Corporate capacity: two largest farm groups comprise ~80% of production	No/infined genetic breeding program of crossborder movement protocols
Limited scale as a niche supplier to promium global markets	No common grading space used or reported across industry
	Low level of collation (reporting of key data Labour, product space, OHS atc
95% of farm production is from AAGA Members	Low level of collation/reporting of key data - labour, product specs, ons etc
	Out-of-date AAGA Constitution relative to emergings peeds
	Member service peeds are increasingly beyond capacity of AAGA executive office
	Member service needs are increasingly beyond capacity of ANGA executive onice
1. Sustainable farms:- social licence to farm, animal weitare, clean water. 2. Uniq 3. Premium Offer:- safe foo	de searood:- uniform size, colour and texture; plump well fed fish; jade green shell. d, live format, free of debris
Droactively evaluate seeding carries to wildesteh industry	
Broaden funding base for RD&E	Lack of engagement in selected precompetitive marketing initiatives - scope out a project and investment concept with leading farm groups
Gather data to describe our social license to operate	Engage wildcatch, chefs and others in collaborative marketing initiatives
Reduce farm insurance expenses through joint farm policy - fire and stock	Lack of sector market profile due to small production volume
Consider AquaPlan, SIA, NAC, Blue Economy CRC, Revise AHAP to be more encompassing	Poor understanding of summer mortality (and cost-effective solutions)
Solve the summer mortality problem	Poor understanding of alternate proteins (vegetarian, non-vegetarian feeds, etc)
Embrace technology: water quality, data capture, mechanisation, feeding, cleaning, harvesting, grading	Poor understanding of impacts of choice re sites, species, age, temperature,
Per Kg of Production: Lower CO2 output AND lower labour costs	Poor understanding of abalone microbiome and gut health
Establish a Trade Mark to differentiate Australia's quality niche brand	Waste of industry R&D investment due to duplication and poor outcome capture
Define key national animal health measures and metrics for diseases	High farm employee turnover due to low satisfaction and poor career planning
Identify, monitor, and manage key farm capacity issues: FTEs, OH&S, SOPS, training	high faith employee turnover due to low satisfaction and pool career planning
Manage RD&E investment more effectively via a new industry committee	Rising expectations of community and regulators regarding social license to operate

Uncertain market impacts as a result of the coronavirus pandemic

THREATS

Strategic Goals 202	5	Outo	omes 2025
1. Farm Innovation	 Establish and implement technologies and procedures to boost farm efficiency Identify, support adoption of productivity gains via automation Establish new protocols, technology to improve stock movement Monitor, report key data- labour costs, product biomass and productivity specs, OHS etc 	1. Tech and 2. Modern 3. Efficient	procedures to drive farm efficiency farm systems - technology, ICT, AI harvesting and stock movement
2. Genetics	 Establish a national AAGA Genetics Program with regulators across all sites to enable and enhance biosecure genetic development Improve nutrition, growth, survival and product quality Understand summer mortality: develop cost-effective solutions 	1. National 2. Enhance leverage a 3. Control	AGA Genetics Program d performance through genetic nd improvement of summer mortality
			of summer mortality
3. Nutrition	 Understand summer mortality: develop cost-effective solutions Identify alternate proteins - seaweed, sites, species, age, temperature, etc Understand feed specifications and impacts - improve farmer choices Understand abalone microbiome and gut health 	2. Alternate 3. Better fe 4. Better m	e feed proteins ed specifications and choices icrobiome / gut health
4. Animal Health & Biosecurity	 Define key national animal health measures and metrics, including for existing and emerging diseases, and benchmarking Establish a national AAGA Abalone Health Surveillance Program Understand summer mortality: develop cost-effective solutions Better understand the link between animal health and farm management 	1. National 2. National 3. Identify/ 4. Integrate	Abalone health status metrics Ab. health surveillance program report summer mortality triggers ed health & management practices
5. Sustainable Farming	 Investigate, enhance the interaction of stocking density - growth - yield Investigate, benchmark energy efficiency options and greenhouse gases Investigate climate change science - optimise mitigation and adaptation 	1. Sustainal 2. Efficient 3. Climate o 4. Possible	ble Stock density+Growth+Yield energy use and reduced GHGs hange mitigation and adaptation onfarm energy generation/benefits
6. Human Capacity	 Establish, benchmark basic farm capacity/tools: OH&S, SOPS, training, etc Establish AAGA program to monitor, document and retain farm staff and improve their career and job satisfaction 	1. Farm cap 2. Farmer au 3. Better sta	acity benchmarks - OHS, etc nd employee career planning ff retention and job satisfaction
	Fngage in selected precompetitive marketing initiatives - scope project and investment	1. Chef eng	agement and tours to farms
7. Market Development	 concept with leading farm groups - Trademark or brand Australian farmed abalone Engage wildcatch, chefs and others in collaborative marketing initiatives Establish, implement common sector grading specs down chain, and reports 	2. Precomp 3. Participa 4. Investme 5. Consiste	etitive joint generic marketing tion in selected trade shows ent in social media platforms nt product grading specs & data
	Review, upgrade AAGA Constitution to meet current and emerging needs		
8. Governance	 Review farm and member service needs, and EO capacity and resourcing Establish an RD&E Subcommittee to guide AAGA/FRDC IPA investments Acquire additional sources of funding to support RD&E Investment 	1. AAGA Co 2. Better RD 3. Adequate	AAGA and service capacity

2. INDUSTRY CONTEXT

Production and Markets

Abalone is a traditional cuisine in Asian cultures, including for China, Japan and Korea. Most (>90%) of Australian abalone production (wild and farmed) is exported to Japan, Hong Kong, China, Singapore, Taiwan, USA, Canada, and the EU. Ongoing immigration and tourism by Asian citizens are also increasing domestic demand for abalone.

China is the biggest producer of and market for abalone. China's switch from rural to urban life is creating a new consumer middleclass. In 2020 the nation has ~60 million affluent consumers (6% of population) each earning at least US\$34,000 p.a., in 21 million households across key cities. Putting aside the impacts of austerity campaigns, coronavirus and other threats, their discretionary "dining out" spend is expected to grow by 10.2% p.a. through to 2022. But many young consumers are less attracted to traditional abalone cuisine - new social media marketing platforms offer ways to engage them.

Australia contributes ~3.0% to global abalone supply, from wildcatch fisheries and farms. Farms operating from 12 sites across four southern states produced around 1,120 tonnes in 2019.

Australian abalone fisheries and farms have established a premium reputation for high quality, safe abalone products, increasingly in live or chilled formats. Declining trade tariffs in China have also supported Australian abalone farm growth.

Australian farms supply multiple formats: 45% frozen in shell, 35% cooked and canned, 15% live, and 5% frozen meat or in consumer pouches. Around 25% of farm supply is sold domestically (40% live, 50% frozen, 9% canned and 1% in consumer pouches). A focus on producing larger size abalone for niche markets is attractive to Australian farmers.

China comprises ~81% of world abalone supply. But coastal farm degradation in coastal environments, coronavirus pandemic restraints, and reduced demand from younger consumers suggest that China's supply will decline 25% by 2025.



Production	2012	2013	2014	2015	2016	2017	2018	2019	2020
Wildcatch '000 t.							Est.	Est.	Est.
Australia	4.5	4.3	3.9	3.8	3.4	3.4	2.9	2.6	2.6
Overseas (incl. IUU)	3.3	3.3	3.4	3.4	3.1	2.9	2.9	2.9	2.9
Total Capture	7.8	7.6	7.3	7.2	6.5	6.3	5.8	5.5	5.5
Aquaculture '000 t.									
Australia	0.6	0.7	0.8	0.9	0.8	1.0	1.1	1.2	1.2
Other excl. China	9.4	10.3	12.2	13.1	15.2	18.1	19	20	20
China	87	106	110	123	135	149	130	112	112
Total Farmed	97	117	123	137	151	168	150	133	133
Global Supply '000 t	105	125	130	144	158	175	156	139	139
Australia '000 t.	5.1	5.0	4.7	4.7	4.2	4.4	4.0	3.8	3.8
Australia share	4.9%	4.0%	3.6%	3.3%	2.7%	2.5%	2.6%	2.7%	2.7%
China aqua share	83%	85%	85%	85%	85%	85%	83%	81%	81%
China aqua growth	19%	22%	4%	11%	10%	10%	-13%	-14%	0%

Regulatory Framework

The Australian farmed Abalone Sector operates in a complex multijurisdictional regulatory environment. Each farm operation is subject to varying levels of regulation from host jurisdictions, including for aquaculture site licensing, biosecurity and stock movement, wastewater, food safety, food labelling, and work health and safety.

While the farmed abalone sector has experienced significant corporate consolidation in the last few years, the disparate regulatory framework across state jurisdictions continues to be a major challenge and disincentive to industry growth and efficiency. On balance, farmers also recognise the positive influence that Australia's advanced biosecurity systems have on their market reputation and seafood supply chains.

To mitigate the risks and costs of regulation on the sector, AAGA intends to continue to encourage Members and regulators to establish sustainability and biosecurity protocols and standards that address the key environmental, biosecurity, animal health and human health risks, and to enable appropriate 3rd party accreditation and verification. This 2025 Plan includes, among other priorities, support for:

- Development of a national farmed abalone Health Program supported by standard health indicators and farm surveillance,
- Development of a national farmed abalone cross jurisdictional Genetics Program including stock movement,
- AAGA participation in the next AquaPlan and related FRDCsupported standards,
- Harmonised jurisdictional legislation,
- Assessment of the feasibility of a National Stock Loss Selfinsurance / insurance.

Industry Partnership Agreement

AAGA Members expect to establish an IPA with FRDC in June 2020 to continue current projects and improve the flexibility, performance and leverage achieved from their collective precompetitive RD&E investments.

Goals and strategies in this 2020-25 Strategic Plan will determine the priorities and leverage the RD&E investment contributed by abalone farmers.



AAGA STRATEGIC PLAN 2020-2025

3. RD&E PROGRAM

Investment Collaboration

The AAGA Executive and Management Committee work with Members, FRDC and stakeholders to establish strategic and RD&E priorities for precompetitive investment.

The following pages present priority areas, roles, responsibilities, timelines and expected outputs and outcomes.

The Industry Partnership Agreement model for industry investment enables industry funding to be raised and directed to RD&E investment (leveraged funds), AAGA operational costs and other AAGA priorities.

The AAGA and FRDC IPA allows investment in industry specific projects over a specified period against agreed industry strategic needs.

AAGA will establish and manage an RD&E Committee framework that invites and welcomes advice, collaboration and investment from sector stakeholders.

Investment Approval

AAGA Members (comprising >95% of production) voluntarily contribute funds to joint RD&E investment projects, managed with FRDC, and using the levy matching powers of the Commonwealth. A 5-step approval process has been established that a new AAGA RD&E Committee will adopt and implement.

AAGA receives formal RD&E proposals from experienced professional researchers, coinvestors and stakeholders.

All proposals to AAGA must clearly demonstrate:

- how the proposal contributes to outcomes described in the AAGA Strategic Plan 2020-25,

- how the proposed investment will achieve a benchmark return acceptable to the AAGA.

Proposals must not contradict Core Values per the AAGA Strategic Plan 2020-25.

Step 5. Project

RD&E Projects considered and approved by AAGA (and FRDC where relevant).

Approved projects will be managed and overseen by AAGA, the AAGA RD&E Committee, (and FRDC where relevant).

Projects must incorporate clear strategies and plans to enable and commit extension of RD&E project outputs and outcomes back to abalone aquaculture farms and industry partners.

Step 1. Priorities

AAGA Strategic Plan 2020-25 established and published.

Researchers, coinvestors seeking AAGA support for RD&E investment projects must address Plan priorities.

Step 2. Pitch

AAGA engages with researchers, coinvestors, stakeholders and advisers re Plan priorities and projects.

Proponent, researchers, coinvestors must engage early with AAGA leaders to discuss and pitch their RD&E concept. Project concepts are refined early and progressed with clarity and endorsement, or rejected.

Step 3. Performance

AAGA Members seek to achieve a commercial rate of return on their investment in all RD&E activities. Project benchmark rates of return established by AAGA where appropriate.

Subject to its specific investment horizon and projected outcomes, each investment must be able to demonstrate how it will monitor and achieve an acceptable rate of return for assessed risk at or above a benchmark rate established by AAGA.



Investment Capacity

The following table summarises the actual and forecast Australian farmed abalone harvest and related funding that sector members will contribute under their IPA with FRDC. These funds will be contributed, matched, managed and invested jointly with the FRDC subject to the priorities described in this Plan.

BASE CASE Nominal prices	Years ending June	2016	2017	2018	2019	2020	1 2021	2 2022	3 2023	4 2024	5 2025
		Actual	Actual	Actual	Actual	Actual [#]	Forecast	Forecast	Forecast	Forecast	Forecast
Farmed Abalone Harvest	tonnes	815	971	1,149	1,172	1,161	1,438	1,714	1,991	2,249	2,510
Estimated Farm Gate Price	Nominal \$/kg	\$37.86	\$40.00	\$42.45	\$40.80	\$38.00	\$38.00	\$39.00	\$40.00	\$41.00	\$42.00
Gross Value of Production GVP	\$Mill. Nominal	\$30.9	\$38.8	\$48.8	\$47.8	\$44.1	\$54.6	\$66.9	\$79.7	\$92.2	\$105.4
Est. Avg. GVP Available for FRDC Matching @ 0.25% of 3 year average	\$ Nominal	\$71,056	\$81,991	\$98,723	\$112,859	\$117,266	\$122,159	\$138,026	\$167,625	\$198,932	\$231,067
Matching funds from FRDC via IPA	\$ Nominal	\$71,056	\$81,991	\$98,723	\$112,859	\$117,266	\$122,159	\$138,026	\$167,625	\$198,932	\$231,067
Gross Funding Pool	\$ Nominal	\$142,112	\$163,982	\$197,446	\$225,717	\$234,533	\$244,318	\$276,052	\$335,250	\$397,863	\$462,134
Less FRDC Management Fee @ 8%	\$ Nominal	\$11,369	\$13,119	\$15,796	\$18,057	\$18,763	\$19,545	\$22,084	\$26,820	\$31,829	\$36,971
TOTAL IPA Funds Pool Available	\$ Nominal	\$130,743	\$150,863	\$181,650	\$207,660	\$215,770	\$224,773	\$253,968	\$308,430	\$366,034	\$425,163

[#] These are the most up-to-date actual figures available from AAGA. The figures include Ocean Grown Abalone and non-member AAGA farms. These figures will differ slightly from data reported by ABARES. Production and prices for 2020 were lower than expected due to the impact of the COVID-19 pandemic. AAGA assumes production will recover and grow from 2021.

KEY INVESTMENT AREAS

Investment Area	Objectives and Strategies
1. Farm Innovation	 Establish and implement technologies and procedures to boost farm efficiency Identify, support adoption of productivity gains via automation Establish new protocols, technology to improve stock movement Monitor, report key data- labour costs, product biomass and productivity specs, OHS etc
2. Genetics	 Establish a national AAGA Genetics Program with regulators across all sites to enable and enhance biosecure genetic development Improve nutrition, protein source, growth, survival and product quality Understand summer mortality: develop cost-effective solutions
3. Nutrition	 Understand summer mortality: develop cost-effective solutions Identify alternate proteins - seaweed, sites, species, age, temperature, etc Understand feed specifications and impacts - improve farmer choices Understand abalone microbiome and gut health
4. Animal Health & Biosecurity	 Define key national animal health measures and metrics, including for existing and emerging diseases, and benchmarking Establish a national AAGA Abalone Health Surveillance Program Understand summer mortality: develop cost-effective solutions Better understand the link between animal health and farm management
5. Sustainable Farming	 Investigate, enhance the interaction of stocking density - growth - yield Investigate, benchmark energy efficiency options and greenhouse gases Investigate climate change science - optimise mitigation and adaptation
6. Human Capacity	 Establish, benchmark basic farm capacity/tools: OH&S, SOPS, training, etc Establish AAGA program to monitor, document and retain farm staff and improve their career and job satisfaction
7. Market Development	 Engage in selected precompetitive marketing initiatives - scope project and investment concept with leading farm groups - Trademark or brand Australian farmed abalone Engage wildcatch, chefs and others in collaborative marketing initiatives Establish, implement common sector grading specs down chain, and reports
8. Governance	 Review, upgrade AAGA Constitution to meet current and emerging needs Review farm and Member service needs, and EO capacity and resourcing Establish an RD&E Subcommittee to guide AAGA/FRDC IPA investments Acquire additional sources of funding to support RD&E Investment

Investment Area 1. FARM INNOVATION

RD&E Investment Objective		Risks and Rationale	Responsibility	Horizon	Outcome 2025
1.	Establish and implement technologies and procedures to boost farm efficiency	Lack of farm innovation and related adoption of technologies and procedures will reduce farm efficiency, competitiveness and viability.	novation and related adoption of AAGA, FRDC Lon nd procedures will reduce farm efficiency, ss and viability.		1. Efficient abalone farms using latest technologies and procedures.
2.	Identify and support adoption of productivity gains via automation	Terrestrial and aquaculture farm productivity and security can be significantly improved through selective use of the latest farm technology, information and communication technologies, and artificial intelligence. The capital cost investment and returns from these technologies are now compelling for all farms.	AAGA, FRDC, Equipment makers/ suppliers	Long Term	2. Modern farm systems - technology, ICT, AI
3.	Establish new protocols, technology to improve stock movement	There is increasing need to move abalone stock between farms and across borders. National protocols need to be established to enable movement while ensuring biosecurity is maintained. (Solve the "genetic pollution" argument).	AAGA, FRDC	Long Term	and stock movement
4.	Monitor and report key data - labour costs, product biomass and productivity specs, OHS etc	 All Australian abalone farms need to: Decrease unit costs on farm, especially for labour, Improve abalone product specifications and related communication to markets, Improve on farm OH&S management. As Australian farms are relatively small and therefore have high unit costs, any precompetitive investment in monitoring, selective reporting and benchmarking of key metrics will improve sector productivity and outcomes. 	AAGA, FRDC	Long Term	

Investment Area 2. GENETICS

RD&E Investment Objective	Risks and Rationale	Responsibility	Horizon	Outcome 2025
1. Establish a national AAGA Genetics Program	 Abalone farmed in Australia are endemic species and therefore their genetics and related science must be researched locally to optimise sector productivity and outcomes. As the downstream impact of abalone genetics is wide ranging (across stocking, nutrition, yield, market outturn, consumer preferences, etc) AAGA will work with regulators across all sites to establish a national genetics program. Two issues of concern are: Different requirements in different areas, Regulators preventing trade across state borders based on a genetic pollution argument where farmers are being asked to demonstrate a negative. 	AAGA, FRDC	Long Term	 National AAGA Genetics Program Enhanced performance through genetic leverage and improvement Control of summer mortality
2. Improve nutrition, protein source, growth, survival and product quality	Genetic capacity and optimisation directly impacts farm productivity, supply chain mortality, and consumer choices. Sound investment in abalone genetics will improve farm returns at all stages down the supply chain. Need for a wider pool for industry to draw from, including lines for different characteristics.	AAGA, FRDC	Long Term	
3. Understand summer mortality: develop cost- effective solutions	Summer mortality impacts on farms are a significant risk to farm viability. The science is not yet well documented or understood.	AAGA, FRDC	Long Term	

Investment Area 3. NUTRITION

RD&E Investment Objective	Risks and Rationale	Responsibility	esponsibility Horizon			
1. Understand summer mortality: develop cost- effective solutions	Summer mortality impacts on farms are a significant risk to farm viability. The science is not yet well documented or understood.	 Control of summer mortality Alternate feed proteins 				
2. Identify alternate proteins - seaweed, sites, species, age, temperature, etc	Farms need a better understanding of the nutrition choices available to them on a long- term cost effective basis. AAGA seeks to achieve the most sustainable feeds for Members.	AAGA	Medium Term	3. Better feed specifications and choices		
3. Understand feed specifications and impacts - improve farmer choices	Abalone feed is a major cost for farms. The apparent variability of commercial feed grades and related manufacturer specifications is concerning for farmers and a risk to farm productivity. Both increased farmer awareness of risks, and clearer feed specifications from suppliers, are necessary to ensure optimum choices on farms.	AAGA, SARDI, Universities, Feed companies	Medium Term	4. Better Abalone microbiome / gut health		
4. Understand abalone microbiome and gut health	Abalone fed on seaweed (Ulva) are more resilient to high water temperatures, at least in laboratory trials. Understanding the microbiome changes between abalone fed seaweed and formulated feed may assist understanding of summer mortality. Progress research into pre and probiotics for improvement of gut health.	AAGA, SARDI, Universities	Medium Term			

	RD&E Investment Objective	Risks and Rationale	Responsibility	Horizon	Outcomes 2025	
1.	Define a set of key national harmonised animal health measures and metrics, including for existing and emerging diseases, and benchmarking	Animal health is a major risk to farms and to the sector. A harmonised national program of standard metrics, communications, and measures will create the platform that all farms and regulators need to deliver healthy biosecure farms and translocation protocols.	AAGA, State agencies	Medium Term	 National Abalone health status metrics National Ab. health surveillance 	
2.	Establish a national AAGA Abalone Health Surveillance Program	 AAGA helped to establish the AHAP (Abalone Health Accreditation Program), recognised nationally by SCAAH, (Subcommittee on Aquatic Animal Health. AHAP is vital in demonstrating AVG freedom on farms for the purposes of interstate and international trade in live and whole frozen abalone. Expanding the AHAP to other diseases of interest may be required to demonstrate broader disease freedom. (Further discussion required). Collaborative precompetitive investment in Animal Heath and Biosecurity is the most efficient management approach for the sector. AAGA's leadership and engagement with relevant state and national regulators will promote their joint participation and enable a harmonised national program across all farms in all jurisdictions. 	AAGA, State Medium Term agencies		 3. Identification/ reporting of summer mortality triggers 4. Integrated health and management 	
3.	Understand summer mortality: develop cost-effective solutions	Summer mortality impacts on farms are a significant risk to farm viability. The science is not yet well documented or understood.	AAGA, State agencies	Medium Term	practices	
4.	Better understand the link between animal health and farm management	Ill-thrift (poor growth and elevated mortality) is often not understood but may be related to management practices, genetics, nutrition, and water quality, including temperature, dissolved oxygen, ammonia, salinity, pH/CO2. An integrated management approach is required to maximise performance.	AAGA, State agencies and private aquatic vets	Medium Term		

Investment Area 4. ANIMAL HEALTH & BIOSECURITY

Investment Area 5. SUSTAINABLE FARMING SYSTEMS

RD&E Investment Objective	Risks and Rationale	Responsibility	Horizon	Outcomes 2025		
 Investigate, enhance the interaction of stocking density - growth - yield 	Understanding the science and linkage between abalone stock density, growth, and yield is fundamental to farm productivity. This may require a more fundamental approach to the optimisation of water quality parameters. Similar to 4.4 above.	AAGA, FRDC	Medium Term	 Sustainable Stock density + Growth + Yield Efficient energy use and reduced GHGs 		
2. Investigate, benchmark energy efficiency options and greenhouse gases	Energy access, use, emissions and sustainability is increasingly important to farm outcomes and the sector's social license to operate. Include environmental certification, carbon audit etc.	AAGA, FRDC	Medium Term	3. Climate change mitigation and adaptation		
3. Investigate climate change science - optimise mitigation and adaptation	Effective and demonstrable climate change management and mitigation is fundamental to the niche market brand being developed and claimed by AAGA Members.	AAGA, FRDC, NAC	Medium Term	energy generation and other benefits		

Investment Area 6. HUMAN CAPACITY

RD&E Investment Objective	Risks and Rationale	Responsibility	Horizon	Outcomes 2025	
 Establish, benchmark basic farm capacity/tools: OH&S, SOPS, training, etc 	The increasing consolidation, maturity and farm capacity of the sector, means that high cost areas need to be addressed. Human capacity (productivity, efficiency, OH&S, etc) is the highest cost for most farms and one that offers greatest return on investment in the long term.	AAGA, FRDC, Training Institutions	Medium Term	 Farm capacity benchmarks - OHS, etc Farmer and employee career planning 	
2. Establish AAGA program to monitor, document and retain farm staff and key researchers improve their career and job satisfaction	The investment in people to increase farm efficiency and productivity will be most effective when employees and key researchers are also supported to coinvest in a long-term career in the abalone aquaculture sector as employees, managers, researchers and leaders.	AAGA, FRDC	Medium Term	3. Better staff/researcher retention and job satisfaction	

Investment Area 7. MARKET DEVELOPMENT

RD&E Investment Objective	Risks and Rationale	Responsibility	Horizon	Outcomes 2025
1. Engage in selected precompetitive marketing initiatives - scope out a project and investment concept with leading farm groups – Trademark or brand Australian farmed abalone	As a small, sustainable, high quality niche producer serving global abalone markets, AAGA Members have a real incentive to collaborate on precompetitive investment in consumer marketing and Australian brand awareness. This includes establishing national quality standards for third party sensory analysis of our abalone.	AAGA, FRDC	Near Term	 Chef engagement and tours to farms Precompetitive joint generic marketing
2. Engage wildcatch, chefs and others in collaborative marketing initiatives	Engagement with downstream abalone users in consumer markets will enable increased product awareness and loyalty, and greater price leverage than investing solely on-farm.	AAGA, FRDC, DFAT	Medium Term	3. Participation in selected trade shows4. Investment in social media platforms
3. Establish and implement common sector grading specs down chain, and reports	Harmonised national product grading specifications will improve supply chain and market acceptance of Australian farmed abalone as a category. There is increasing need to move to automated grading of harvested stock by weight following use of relaxants.	AAGA	Long Term	5. Consistent product grading specs and data

Investment Area 8. GOVERNANCE

RD&E Investment Objective	Risks and Rationale	Responsibility	Horizon	Outcome 2025	
 Review, upgrade AAGA Constitution to meet current and emerging needs 	AAGA's Strategy and Constitution need to be reviewed due to changes since inception, including a national industry perspective. The industry's competitive environment, and the association's membership, structure and intent, have changed in recent years. AAGA's documents need to be modernized to enable appropriate governance.	AAGA Executive Officer & AAGA Committee, FRDC	Near Term	 AAGA Constitution that meets needs Better RD&E funding and investment management (e.g. CRC Project) 	
2. Review farm and Member service needs, and EO capacity and resourcing	Industry challenges call for new and amended services and communication technology to support Members. The role of the part-time EO is under pressure and needs to be monitored to enable an efficient AAGA.	AAGA Executive Officer & Committee, FRDC	Near Term	3. Adequate AAGA service capacity	
3. Establish an RD&E Subcommittee to guide AAGA/FRDC IPA investments	By global standards, our farms are small but sustainable. Improved, efficient, precompetitive RD&E investment is a key pathway to leveraging the global market niche that AAGA Members are jointly building.	AAGA, FRDC	Near Term		
4. Acquire additional sources of funding to support RD&E Investment	The breadth of potential projects outlined in this Strategic Plan requires much greater funding than currently available. Rigorously managed, integrated, outcome focussed RD&E projects that attract additional outside funds are required.	AAGA FRDC, (e.g. ARC, CRC-P, CSIRO, Universities, etc)	Near Term		

INVESTMENT PLAN

The following table is intended as a forecasting tool reflecting the aspirations and priorities identified in the February 2020 AAGA Strategic Planning workshop. AAGA's investment plan needs flexibility to respond to changing risks, priorities and opportunities, as the coronavirus pandemic has reconfirmed.

FORECAST GROWTH	Years ending June	2016	2017	2018	2019	2020	Total 2016-20			1. 2021	2. 2022	3. 2023	4. 2024	5. 2025	Total 2021-25
		Actual	Actual	Actual	Actual	Actual				Forecast	Forecast	Forecast	Forecast	Forecast	
Harvest	tonnes	815	971	1,149	1,172	1,161	5,268			1,438	1,714	1,991	2,249	2,510	9,903
Farmgate Price	\$/kg	\$37.86	\$40.00	\$42.45	\$40.80	\$38.00				\$38.00	\$39.00	\$40.00	\$41.00	\$42.00	
Est. Sector GVP	\$Mil.	\$30.9	\$38.8	\$48.8	\$47.8	\$44.1	\$210.4			\$54.6	\$66.9	\$79.7	\$92.2	\$105.4	\$398.8
Est. IPA RD&E Funds Pool Available	\$Nom.	\$130,743	\$150,863	\$181,650	\$207,660	\$215,770	\$886,687			\$224,773	\$253,968	\$308,430	\$366,034	\$425,163	\$1,578,368
Investment Area									<u>F</u>	Planned Inves	tment Horizo	n and Expen	<u>diture</u>		
1. Farm Innovation	\$Nom.							Long Term	19%	\$42,707	\$48,254	\$58,602	\$69,546	\$80,781	\$299,890
2. Genetics	\$Nom.							Long Term	19%	\$42,707	\$48,254	\$58,602	\$69,546	\$80,781	\$299,890
3. Nutrition	\$Nom.							Medium Term	18%	\$40,459	\$45,714	\$55,517	\$65,886	\$76,529	\$284,106
4. Animal Health & Biosecurity	\$Nom.							Medium Term	10%	\$22,477	\$25,397	\$30,843	\$36,603	\$42,516	\$157,837
5. Sustainable Farming	\$Nom.							Medium Term	5%	\$11,239	\$12,698	\$15,422	\$18,302	\$21,258	\$78,918
6. Human Capacity	\$Nom.							Medium Term	5%	\$11,239	\$12,698	\$15,422	\$18,302	\$21,258	\$78,918
7. Market Development	\$Nom.							All Terms	5%	\$11,239	\$12,698	\$15,422	\$18,302	\$21,258	\$78,918
8. Governance	\$Nom.							Near Term	19%	\$42,707	\$48,254	\$58,602	\$69,546	\$80,781	\$299,890
TOTAL	\$Nom.								100%	\$224,773	\$253,968	\$308,430	\$366,034	\$425,163	\$1,578,368

Glossary

Australian Abalone Growers Association
Artificial intelligence
Abalone Viral Ganglioneuritis
Commonwealth Dept of Foreign Affairs and Trade
European Union
Fisheries Research and Development Corporation
Industry Partnership Agreement
Information and communication technology
Illegal, Unreported and Unregulated fishing
National Aquaculture Council
Non-government organisations
Occupational health and safety
Seafood Industry Australia

State Agencies Convenient collective term for the variously named state departments administering aquaculture and fisheries