science & technology
Department:
Science and Technology
REPUBLIC OF SOUTH AFRICA

POLICY BRIEF

AQUACULTURE:

Managing the sector to increase the potential for growth and therefore economic opportunities for historically-disadvantaged individuals and communities

1 Introduction

The Department of Science and Technology has been supporting fresh and salt water aquaculture projects outside of an organisational policy framework for a number of years.[i] While the DST is not a lead department in the aquaculture sector, amongst other things, the Department is expected to advise about technology transfer systems that can alleviate poverty and achieve sustainability. As a result of changes in policy, and the introduction of an aquaculture finance facility[ii], the time has arrived for the DST to guide its aquaculture portfolio more formally. This policy brief therefore sets out to introduce a framework for DST's involvement in the aquaculture sector that draws upon some project experiences, industry and intergovernmental interactions and research. The brief starts by setting out the main problem to be solved. A review of existing practice, policy and research is then used to break the main problem down into smaller, more manageable growth and empowerment problems. Finally, a feasible integrated solution, or way forward, is proposed.

2 The problem in its context

The absolute and relative size of the South African aquaculture[iii] sector can be described as small, no matter the measure, nor timescale, that is used. South Africa has not been following the same macro trend that is shown in recent world fisheries and aquaculture statistics. First, our inland aquaculture has not grown nearly as rapidly as elsewhere and second, our marine aquaculture did not grow nearly fast enough to make up for the decline in the tonnes of fish captured from marine fisheries (see FAO, 2012).

To partly explain this, it is common for people to say that South Africa has a very rough coastline that involves high energy effort to catch marine living resources, while providing comparatively poor conditions for marine aquaculture. People may also say that there are few really competitive locations for fresh water aquaculture within South Africa.

So, one argument goes as follows. Without the natural resource endowment, the fjords or archipelagos, the favourable river and lake systems and beyond the seaweed, abalone, mussels, oysters and trout (DAFF, 2011), the aquaculture sector in South Africa is a marginal player and shall remain so, no matter if one adds finance, efficient governance and the technical and social capacity to chase rising fish and fish product demand, or prices.

Another argument could be that South Africa has lots of natural potential for aquaculture, although it is difficult to realize without

innovation. The present ocean environment around South Africa involves a complex and diverse system of energy and nutrient flows (van der Elst, 1993, Lutjeharms *et al*, 2001 and Branch, 2008) and, not surprisingly, a diversity of marine life, not all of which is edible. In fact, quite a number of species are very colourful and / or poisonous.[iv] The same is true for the inland fresh water aquatic environment (as influenced by its geological history) i.e. lots of evolutionary complexity and diversity (Tyson *et al*, 2001 and Skelton, 2001) and not every aquatic life form is a food or industrial product.

As it is with agriculture, harnessing the existing energy and nutrients within the environment, effectively, involves integrating many knowledge areas (climate, production, marketing and sales). Unfortunately, certain types of aquaculture involve the extra logistical challenges of human work off-shore. If the strategy in response to this is to add external energy and nutrients into a more controlled, safe and workable aquatic environment on land, the challenge is then to feed and grow species on foodstuffs, and in water, that is largely alien to their wild relatives. As the history of domesticating aquatic species is said to be much shorter and less successful than the history for land-based agriculture, this can lead to some pressure to import and use the limited number of global species or breeds where the feeding and growth problems have already been resolved. However, if the species selected and improved for consumption, escape, they may create an imbalance within existing ecosystems, as has happened with exotic introductions before.

There is a third argument. It is not environmental complexity or environmental constraints that are the cause of sluggish aquaculture growth; it is the government's regulatory environment that is causing the problem. In 2013, the Department of Agriculture, Forestry and Fisheries (DAFF) commissioned a review of legislation regulating "aquaculture". In addition to the 40 Acts with a bearing on aquaculture that were subjected to review (EnAct, 2013), there is also the Sea Fisheries Act, the Maritime Transport Act, the Maritime Traffic Act and the Spatial Planning and Land Use Management Act. That makes at least 44 pieces of legislation and related administrative systems that may need to be navigated. There is a perception that each administrative step in the system takes to long and that the overall process is not streamlined. Regulatory risk can contribute to slow sector growth as investors plot the minimum and maximum estimated timeframes and costs before production can actually start.

Finally, as the last argument, aquaculture is sensitive to pollution and disease risks. If there are few appropriate and safe aquaculture sites left, or there is a risk of future pollution and disease, aquaculture investors contemplate risks that are either impossible, or very expensive, to mitigate against. This may also partly explain the slow growth of the sector.

No matter which argument holds more water, if there are few South African aquaculture growth prospects in evidence, how can this sector hope to promote the empowerment of black people? Or stated differently, without the empowerment of black people, how can you expect the sector, and its ancillary functions,[v] to grow sustainably?

So, the main problem for this policy brief is to start to define the optimal balances between empowerment and economic growth in aquaculture over the next five years.

In section 3, we review the main types of empowerment platforms and relate them to the problem of growth and empowerment. In section 4, we propose a high level solution to the problem of low growth and empowerment by focusing on medium term priorities.

3 Review of prospects from empowerment platforms

We used the literature to give each platform within South Africa three scores: a) a growth and sustainability score, b) an empowerment score, and c) a regulatory constraint score.

The bibliography, summary of findings, scores, directory and maps derived from this review are available from the DST in an electronic format on request.

3.1 The Community Drives Empowerment

Our literature review did not reveal many examples where the community was a driver of their own empowerment in aquaculture. This may reflect low affordability, and access, by most consumers within South Africa to quality aquaculture products and / or low confidence in aquaculture as a viable production opportunity relative to land based agriculture. We did not find a generic marketing or consumer empowerment platform that aims to raise mass consumer awareness about the nutritional benefits of salt water or fresh water aquaculture products in human or animal nutrition and in the management of water quality more generally. We expect that the most active participation in aquaculture shall arise from communities who are reaching the limits of wild harvesting their nearby aquatic resources. Next most demanding could be communities who see a way to start resolving water quality problems through some form of aquaculture. For the few examples of community driven empowerment that we found, no regulatory constraints on growth were mentioned, once operational. Passionate communities could drive five types of empowerment platform.

- Consumer Empowerment
- Household aquaculture farm
- Seeking state support
- Self-empowerment using existing natural resources
- Voluntary associations, clubs and societies

The only one that is not self explanatory "Seeking state support" can be clarified using this example:

> It was reported that in 2001, members of the local community approached the Department of Agriculture for assistance in starting the Dakari Holiday Resort and Fish Venture project. The group estimates that it produces approximately 12 000 ornamental fish per year (Britz and Rohani, 2004).

3.2 The State and Public Sector Drives Empowerment

South Africa has a very long history of introducing cold, fresh water, species such as trout into dams and rivers via state supported hatcheries. A similar, and reportedly less successful economic history, exists for warm water species hatcheries (mostly tilapia and catfish) that supplied greenhouse and pond aquaculture farms. There have been several warm species project failures and few commercial producers are known to have achieved success. A few hatcheries supported the development of indigenous yellowfish.

By 1990, there was a change in policy that reduced state support for this wide network of hatcheries. In 2004, there were still remnants of this system, either in the form of dormant facilities with staff, or more active facilities with institutional links to Universities or Colleges, or private sector investors. Few of the hatcheries reported about their extension systems and there were several examples of sub-optimal support to government supported aquaculture project farms, who, in turn, reported negative growth results. It is notable that past state support had almost no emphasis on marine animal species hatcheries or plant based aquaculture species. There are no plant aquaculture genetic reference laboratories as were built for protecting and using plant genetic resources on land.

Probably, the largest volume of literature reviewed concerns monitoring water quality indirectly via the health of indigenous aquatic species (and rarely some aquaculture species), either in an ecosystem or within a laboratory environment. The aquaculture empowerment and growth impact of these activities is not reported about and appears to be overshadowed by the water quality concerns arising from industrial, mining, residential and agricultural land use. The next most voluminous body of research concerns

marine biology, where networks of researchers have developed very few practical links with the aquaculture sector. Aquaculture is a small domain when compared with water resource management and marine biology, yet it may have some potential to act as the catalyst for joining these domains, productively. We found 26 types of state driven aquaculture platforms as follows:

- Alternative use of waste-water ponds
- Aquaculture by-products from water treatment and / or water quality monitoring research
- Aquaculture food security project
- Aquaculture pilot projects beyond the natural or adapted range of a species
- Aquaculture rescue projects in areas of depleted natural resources
- Aquariums
- Aquariums reaching out
- Artificial reefs
- Bulk infrastructure investments for an incubated land-based aquaculture zone
- Estuarine aquaculture
- Gene bank / reference laboratory
- Institute, University and College Education Platforms - Outreach - low trophic level
- Institute, University and College Education Platforms - Outreach – middle trophic level
- Institute, University and College Education Platforms - Outreach – high trophic level
- Institute, University and College Education Platforms - Outreach – polytrophic levels
- Port and harbour aquaculture development zones
- Protected areas
- Ranching
- Research station
- Reseeding the wild
- School Education Platforms
- State hatcheries
- State innovation, LED and empowerment financiers
- State veterinary services
- Transport / distribution

3.3 The Private Sector Drives Empowerment

The core set of privately owned facilities that traditionally makes up the aquaculture industry may not be the best, or only, way to promote the development of the sector. With a decline in sea going fish capture and landings, some leaders within the aquaculture industry, have not been shy to present Feed Conversion Ratios (FCR) that involve the use of small fish to produce bigger fish that can be beyond intensive broiler industry FCR norms. With the possible exception of trout, most private sector growth in South Africa has also been concentrated lower down the food / energy chain, than in fin fish and carnivores. So, in addition to the aquaculture farm, we could focus on what is happening at aquaculture equipment suppliers and designers, feed raw material suppliers, feed manufacturers, hatcheries, fish processing establishments, oil rigs, veterinarians and life sciences companies to find growth and empowerment opportunities. As government, we need to know more about viable sustainable aquaculture enterprises that are mainly focused on empowering their own staff, or staff elsewhere in the value chain.

We were impressed by the way the abalone feed industry has integrated University research with product development and improvement. We are also impressed by how co-defined research was sequenced and timed to take place within private sector premises. We are even starting to develop the perception that aquaculture feed manufacturers could be the most strategic platform for launching aquaculture research and development work in support of sector growth. If it is not the feed companies then it must be the hatcheries, who appear to be most sparkling and dynamic. We are also

grateful to those companies who trained aquaculture government project beneficiaries and those who developed and implemented certificated training programmes for their staff. We found the following types of empowerment and growth platforms within the private aquaculture sector:

- Aquaculture satellite-growers linked to an existing enterprise
- Core private sector aquaculture enterprises – low trophic level
- Core private sector aquaculture enterprises – middle trophic level
- Core private sector aquaculture enterprises – high trophic level
- Core private sector aquaculture enterprises – polytrophic levels
- Farm worker access to land and related resources for aquaculture
- Follow-ons from failed large-scale aquaculture
- Private sector aquaculture farms
- Private sector aquaculture feed manufacturers
- Private sector aquaculture feed raw material suppliers
- Private sector aquaculture processing facilities
- Private sector capital equipment and service suppliers
- Private sector driven aquaculture parks
- Private sector hatcheries
- Private sector research station
- Private veterinary services
- Training and technology transfer to new entrants at existing enterprises
- Training and technology transfer to new entrants via sector associations

4 Proposed Solution

Given the nature of the literature review, the number of active platform we found and the patchy information provided within documentation, at this stage, we can only propose high level recommendations.

4.1 Highlight Priority Aquaculture Sub-Sectors

Aquaculture market knowledge and market research should be combined with proper assessments of production capability to better communicate future research and development needs. Primarily, Institutes,

4.2 Coordinate Funding to Complete an Aquaculture Strategic Environmental Assessment

Aquaculture research at any platform should be designed to follow the lifecycle / developmental biology of the species concerned and funding may be wisely programmed to facilitate this. It appears that

Universities and Colleges need have sufficiently forward looking information to build and manage problem solving research teams.

Government should report clearly about how aggregate research and development funding support was allocated to aquaculture and should publish performance metrics for empowerment, growth and sustainability that supports effective implementation. Government should provide and fund industry information support services that perform according to standards. Government must build and maintain an economic history and economic forecasting system that is relevant to each aquaculture platform within South Africa.

it could help to structure aquaculture research into programmes, whereby:

a) teams of specialists implement discrete research and production projects (i.e. the biological stock / resources produced by one project team working on earlier lifecycles is used in other projects by teams working on later lifecycle stages in a

transparent system of chain dependency); and / or

b) one team of generalists or integrators may also be used to design and integrate research about many lifecycle stages.

Aquaculture research findings should be published in a way that provides more formal "protocols" for the production of a species to maturity, or only part of its lifecycle (see Moretti, A et al 1999a and 1999b).

Critically, findings from aquaculture production research and development should be packaged into a common knowledge Aquaculture Strategic Environmental Assessment (ASEA). ASEA should use Catchment Management Areas (CMAs) as the main unit for reporting about transformation, effective planning integration and achieving growth.[vi]

4.3 Use Research to Agree about Key Performance Measures to Manage Platforms

There needs to be agreement about a minimum core report for an aquaculture empowerment platform, be they within private or public sector premises. With some common reporting elements, the role and effectiveness of each platform can be mapped into one ASEA. With accepted key performance measures, existing research can be used in risk and hazard analyses and in planning space for additional sector participants. ASEA does not set out to duplicate existing aquaculture legislation, policy or strategy, it aims to properly record aquaculture activity as it happens and project plans forward. ASEA aims to bring the aquaculture, fisheries and forestry, plus the marine biology and the water resource domains together to form a monitoring and management framework for improved system performance.

4.4 Target Incentives and Relax Regulations for Aquaculture Activities in Accordance with a Strategic Environmental Assessment

Australia has already been through several of the troubles associated with regulating aquaculture and fisheries. Instead of requiring upfront assessments prior to issuing a permit, a fisheries or regional level management plan can be used to guide first time approvals, while post-activity impact statements as suited to species, scale and technology can be used to guide renewals and to build a firm's know how. Independent researchers can verify if impact statements are valid and sufficiently detailed for effective resource management at the level of a region or industry. After all, in close proximity, aquaculture activities are usually very sensitive to pollution themselves. Government incentives or surety for expansion can be linked with the agreed key performance measures and if managed properly, affordable, popular and quality fish should be more readily available to the common people. A key intention is to remove biases and impediments to Human Capital Development amongst rural people who are interested in aquaculture, as broadly as we have defined it, within a catchment

5. Conclusion

Whilst efforts are underway to ensure that the sector is managed for long-term growth, concerted efforts are required around the management of the integration of platforms for promoting the inclusion of historically disadvantaged people and communities in a manner that effectively taps into knowledge of government (and its agencies), the private sector and communities.

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Endnotes

[i] The same aquaculture projects were part of a more widely accepted aquaculture research and development programme that was discussed amongst government and the private sector. In this sense, they took place within an emerging government policy framework.

[ii] The Department of Trade and Industry launched the R800 million Aquaculture Development and Enhancement Programme (ADEP) in April 2013. From 1 September 2012 to 31 March 2018, the programme offers cost-sharing finance linked to the achievement of productive investment, black economic empowerment and job creation (DTI, 2013). The programme anticipates that existing enterprises, educational and research institutions shall invest their resources to establish or expand production platforms that can secure the government co-finance. ADEP appears to cater for most, but not all, empowerment typologies (i.e. it may not clearly cater for artificial reefs, estuaries and aquariums and it may not offer much support to relieve constraints in related and supporting services and industries).

[iii] Here, aquaculture is defined as farming, ranching or enhancing the stock of aquatic populations. It implies that "the farmer" has sufficient knowledge of how habitats function, whether they be initially pristine, slightly modified or entirely artificial. Aquaculture technology includes constructing underwater structures, reseeding wild populations, cage culture and water flow through or water recirculation farms. It therefore seems that the only thing that sets "aquaculture" apart from "capturing" is the definition of "wild". In terms of this definition, fisher folk and fishing companies catch or capture aquatic living resources from the wild with fishing gear and effort, while fish farmers intervene by more than simply removing stock from an environment. Drawing an imaginary boundary around a wild sanctuary and preventing catch and capture through enforcement is not defined as "aquaculture". A ship that sunk that helps to form a reef and that is then defined as a sanctuary is also not "aquaculture", while deliberately off-loading a ship of vehicle junk to create an artificial reef is "aquaculture". Finally, it is possible that "aquaculture" includes the "domestication" of wild species, however, this is rarely discussed in aquaculture literature.

[iv] In using the word diverse, there can be a need for modesty. For example, a description of South Africa's sponge biodiversity puts the number of Poriferans at 314 while Australia is said to have 2426 species (http://www.biodiversityexplorer.org/mm/sponges/index.htm). Either way, sponges provide valuable indicators of ecosystem health and more practically facilitate a useful link between the pelagic and benthic environment and can be used in waste remediation.

[v] Of the many related and supporting functions that can be defined, we list the following as notable: a) breeding (DNA marking, chromosome set manipulation, hybridisation, selective breeding and genetic engineering), b) feed / food manufacture (for animals [trash fish and artificial feed] and plants [substrates and growing mediums]), c) infrastructure and equipment (fixed, mobile) and d) diagnostic services for breeding, production and sale (environmental health, nutritional deficiencies, pests, diseases and food safety and quality).

[vi] The reason for using catchments to support aquaculture mainly relates to the integration of knowledge about water quality, land use / human settlement, flora, fauna, waste / nutrient resource and pollution flows, not only on land, but continuing down into the sea.