

Reducing Rural Poverty and Improving Lives through Sustainable Aquaculture: AQD's 40-year Saga of Mustering Strength and Expertise for Technology Development

SEAFDEC Aquaculture Department

Recognizing the need to promote fisheries development for improving the economies of Southeast Asian countries, the Second Ministerial Conference for the Economic Development of Southeast Asia held in Manila, Philippines in April 1967, agreed to establish the Southeast Asian Fisheries Development Center (SEAFDEC) based on the recommendations from the First Ministerial Conference for the Economic Development of Southeast Asia in Tokyo, Japan in April 1966 and the subsequent Conference on Agricultural Development in Southeast Asia organized in Tokyo, Japan in December 1966.

As soon as the necessary documentations were completed, signing of the Agreement Establishing SEAFDEC took place in Bangkok, Thailand on 28 December 1967 by the Governments of Japan, Malaysia, Republic of the Philippines, Singapore, Thailand, and Republic of Vietnam, while the establishment of the Marine Fisheries Training Department in Thailand and Marine Fisheries Research Department in Singapore, under the SEAFDEC umbrella was also finalized.

Two years later during its Second Meeting in Singapore in March 1969, the SEAFDEC Council agreed in principle, to establish a new SEAFDEC department to carry out research and development in the field of aquaculture, and organized a study group to identify the appropriate site of the department as well as to draft its plan of operation and working program.

During the Fourth Meeting of the SEAFDEC Council in Manila, Philippines on 18-22 January 1971, then Philippine Secretary for Agriculture and Natural Resources Arturo R. Tanco, Jr. informed the SEAFDEC Council that the Philippines had entered into a bilateral agreement with the United States Agency for International Development (USAID) for the implementation of an aquaculture project in the Philippines.

It was also during that same Meeting that Secretary Tanco invited the Council to consider incorporating the said aquaculture project into the activities of the proposed new SEAFDEC department to avoid duplication of efforts, and requested the Council to also consider the establishment of such department in the Philippines. Therefore, having considered the position paper of the Philippine Government, the Council agreed in principle, to establish the SEAFDEC Aquaculture Department in the Philippines.

Based on results of the series of surveys conducted by a team of Japanese and Filipino aquaculture experts, and after securing the commitments of the Governments of Japan and the Philippines to support the operations of the new department, the SEAFDEC Council at its Sixth Meeting in Kuala Lumpur, Malaysia on 3-7 July 1973, agreed to formally establish the Aquaculture Department in Iloilo, Philippines, with the main function of carrying out research, training and extension activities in fish culture, and the rest is history.

Now, SEAFDEC has four existing Departments: (Marine Fisheries) Training Department (TD) in Thailand, Marine Fisheries Research Department (MFRD) in Singapore, Aquaculture Department (AQD) in the Philippines, and Marine Fishery Resources Development and Management Department (MFRDMD) in Malaysia. A new department, the Inland Fishery Resources Development and Management Department (IFRDMD) is expected to be formally established very soon in Indonesia.

Meanwhile, the Member Countries of SEAFDEC now include all the ASEAN member states, namely: Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam, plus Japan.

It is well recognized that aquaculture is an age-old practice, and its development went through a range of multi-faceted and multi-tiered stages. In the past, immature fish or shellfish were harvested from nature and transferred to artificially-constructed environments, *e.g.* earthen ponds, to extend their growth. The development continued when fish eggs were collected and fertilized in artificial environments, and the hatchlings were grown to commercial sizes. Eggs and sperm were pressed out from the bodies of male and female broodstocks, mixed together under favorable conditions for hatching, after which the resulting fry and fingerlings are cultivated in ponds or tanks or cages. As the life cycles of various aquatic species were ascertained,

these were adapted to induce the sexual maturation and reproduction of such species.

Although during the early part of aquaculture development, high-value fishes were the main focus but later, as new technologies evolved for cost-effective cultivation of fish, the culture of low-value fish was promoted to produce fish that could contribute to improving the lives of people and reducing poverty in rural areas. This latter development could be considered as the era of modern aquaculture and it was at this period that the Aquaculture Department (AQD) of the Southeast Asian Fisheries Development Center (SEAFDEC) made an entrance into the realm of

aquaculture development in Southeast Asia, and started its journey towards reducing poverty in rural areas through sustainable aquaculture.

FAO defined aquaculture as “*the farming of aquatic organisms including fish, molluscs, crustaceans and aquatic plants. Farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, and protection from predators, among others...*”. Based on such definition and in accordance with the mandates bestowed during its establishment in 1973, AQD has been promoting and undertaking aquaculture research on various aquatic commodities that are relevant and appropriate for the Southeast Asian region; developing human resources for aquaculture advancement; and disseminating and exchanging information on aquaculture.

While embarking on massive infrastructure and facilities development especially in the early days of its establishment,

AQD also started to mobilize regional scientific and technical manpower for its aquaculture R&D activities. Thereafter, the swelling momentum of its research and development activities which has been sustained, eventually led to significant advances in aquaculture development. As a result, aquaculture today is no longer dependent on wild seedstocks since technologies for all aspects of full-cycle aquaculture have been developed by AQD for most of the economically-important commodities.

Remembering the Past 40 Years of AQD

For 40 years, AQD has mustered its strength and the support of stakeholders for the sustainable development of aquaculture in the Southeast Asian region. From the outset, the research thrust of AQD has been geared towards the development of appropriate technologies to increase food production through aquaculture. Focus was therefore placed on R&D areas specific to economically-important species

Box 1. Important contributions of AQD to the advances in aquaculture development

Giant tiger shrimp: AQD’s innovative works on the biology, broodstock management and maturation of the giant tiger shrimp had been largely instrumental in the development of the shrimp hatchery. Results of AQD’s studies on shrimp nutrition, health management and grow-out culture have been very relevant to the needs of the advancing shrimp industry in the Southeast Asian region.

Milkfish: AQD’s pioneering studies on reproduction, larval biology and nutritional requirements of milkfish led to captive breeding and production of high quality milkfish fry. Hatcheries now supply most of the fry and fingerling requirements of the milkfish industry which dramatically expanded from traditional brackishwater pond culture to pens and cages in freshwater bodies and coastal waters. Such feat also served as model for improved fishpond culture technologies which could be adapted for the culture of various commodities in other countries of the region.

Mud crab: The use of wild crablets in mud crab culture, especially in the Philippines which has a long history of mud crab farming, has led to the dwindling mud crab resources. In order to address such concern, AQD developed the technologies for mud crab hatchery, nursery and farming focusing on *Scylla serrata*, which are now being adapted in other Southeast Asian countries.

Tropical abalone: The success of AQD in completing the life cycle of abalone in captivity has led to the promotion of the responsible culture of this species. For the tropical abalone *Haliotis asinina*, AQD has also developed the techniques for mass seed production, formulated diets for juveniles, tested grow-out culture in floating cages, initiated sea ranching and stock enhancement activities, and pilot-tested abalone hatchery technology with the private sector. The technologies developed are being disseminated through AQD’s abalone hatchery and grow-out training course being offered annually.

Tilapia, carp and catfish: After the establishment of AQD’s Binangonan Freshwater Station near Laguna Lake in 1976, AQD embarked on freshwater aquaculture R&D, focusing on the Nile (red) tilapia, bighead carp and the native *clariid* catfish. Since then, breeding and seed production techniques, feed formulations, farm-based genetic selection schemes and methods on the application of DNA markers in stock management have been developed, and disseminated to aquafarmers through training and information activities. AQD is also pursuing research on indigenous freshwater fishes like the silver therapon and climbing perch for sustainable aquaculture and biodiversity conservation.

Commercially-important marine fishes: Considering the high demand for live reef food fish due to the health benefits of eating fish that leads to the brisk expansion of live reef food fish trade (LRFFT), AQD developed the technologies for captive breeding, fry production, farming systems, and feed development and management of high-value marine fish species such as rabbitfish, pompano, mangrove red snapper, sea bass, and groupers. The full-cycle aquaculture of these species will help ease the pressure on wild fisheries and at the same time support the sustainability of LRFFT for the benefit of small-scale fishers and farmers in the Southeast Asian region.

Seaweeds: In an effort to sustain seaweeds as top export commodity of the Southeast Asian region, AQD put together a team of experts to help maintain the competitiveness of the region’s seaweed industry in the world market. The team focused on improving the farming technology of *Kappaphycus* spp. and *Gracilaria* spp., and developing new strains of *Kappaphycus* spp. Farming of these commercially-important red seaweeds could provide alternative livelihood for poor fishers and coastal dwellers in the Southeast Asian countries.

Giant freshwater prawn: In the early 2000s, AQD initiated the genetic improvement of the giant freshwater prawn *Macrobrachium rosenbergii* with the cooperation of research institutes in Thailand and Indonesia. As a result, seed production studies improved the survival in the hatchery by up to 70% while AQD was able to successfully develop lake-based cage culture technology which had been transferred to stakeholders through training and information dissemination activities.

Mussels, oysters and kapis shell: AQD has developed a technique for mussel and oyster culture, the hanging raft method, which is being promoted to farmers because it is more environment-friendly, results in better growth and gives higher financial returns. For the *kapis* shell *Placuna placenta*, AQD developed sustainable broodstock management and spawning techniques, and juvenile production in hatcheries. AQD’s initiative in the restocking of the *kapis* shell along the Panay Gulf starting in the late 90s resulted in recruitment and bountiful harvest ten years later.

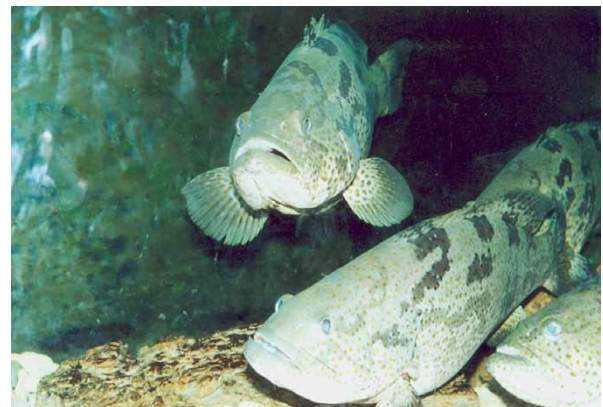


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of fish, crustaceans, molluscs, and seaweeds. Specifically, breeding and culture technologies were developed for giant tiger shrimps, milkfish, tilapia, carps, catfish, mussels, oysters, giant freshwater prawn, and high-value marine fishes such as sea bass, groupers, red snapper, rabbitfish, and pompano. Later, aquaculture technologies were also developed for seaweeds, abalone, mud crab, and sandfish, while research activities on mangroves, stock enhancement and community-based fishery resource management were conducted to better protect the aquatic resources while ensuring that resource users continue to benefit and profit from resource use. With more innovations in fish farming technologies through research-and-development to which AQD plays an important role, especially in Southeast Asia, fish farms can now be both profitable and environment-friendly. The important advances achieved by AQD for the past forty years are summarized in **Box 1**.

While AQD continued to reach out to more users and beneficiaries in promoting the technologies it has generated, in the late 1990s a new paradigm of the research-extension continuum was adopted by AQD through intensified aquaculture technology verification and technology transfer. Along this thrust and responding to fishers' concern on declining fish catch, AQD embarked on a pilot community-based fishery resource management (CFRM) project to address the poverty alleviation agenda of small-scale fishers. Utilizing participatory techniques and community-based management principles, AQD engaged the technology users in a community of Malalison Island in Culasi, Antique in west-central Philippines, for its pilot CFRM activity. This resulted in reformed practices on resource use in Malalison Island, *i.e.* from rampant illegal fishing practices to co-managing of fishery resources by the same resource users. Based on this experience, multi-disciplinary, community-based and participatory R&D have become the hallmarks of AQD's approach to development-oriented projects like the uptake of small fishers and farmers on aquaculture technology development through institutional capacity building for sustainable

aquaculture mechanism, stock enhancement, and coastal resource management. With its reliable track record in seed production of aquatic species coupled with the successful experience in CFRM, a resource enhancement program was set up in 2000s to nail the technology gap in the culture and capture fisheries. The program entails the releasing of seedstocks reared in hatcheries-nurseries into natural waters, to be managed and eventually harvested by coastal communities. Unlike pond culture which requires high capital investment, the grow-out culture part of resource enhancement needs minimum level of financial outlay. The program promotes the effective protection of restocked juveniles through regulations of harvest sites, sizes, and seasons, by local communities and governments through adequate social organization and enhanced local governance. In addition, environmental protection of the habitats is promoted, *e.g.* sea grass beds, coral reefs, and mangroves, where the released commodities, *e.g.* clams, shells and crabs can survive and grow to marketable sizes. Following such approach, AQD has developed stock releasing-enhancing technologies for the abalone, giant clams, sea horses, and sandfish. For the abalone, AQD developed a shell-marking technique to tag the hatchery-bred seeds prior to releasing and stocking them into the natural environments. Nursery rearing of the giant clam *Tridacna gigas* has also been conducted at AQD's facilities, while sea horses (*Hippocampus barbouri* and *H. comes*) are being propagated at the AQD hatcheries for possible release in marine reserves. AQD has also continued to



improve the techniques for sandfish hatchery and nursery production to improve growth and survival in release sites.

As aquaculture developed rapidly, uncontrolled and irresponsible use of chemicals and drugs could not be averted, and this led to the emergence of a number of infectious diseases threatening the sustainability of aquaculture. To address this concern, AQD embarked on a long-term fish disease management program which includes establishing effective control measures against fish diseases and monitoring chemical and drug use in aquaculture. Using the results of its studies on the biology of known pathogens, AQD developed the protocols for treating bacterial, fungal, parasitic, and viral diseases, which were then applied for cultured species in hatcheries, ponds and cages resulting in improved survival rates. Moreover, the application of polymerase chain reaction (PCR) techniques has revolutionized fish disease diagnostics at AQD.

Being part and parcel of modern aquaculture, the development of cost-effective formulated diets, traditionally derived from low-value fish that are becoming less available, impractical and costly, and considering their benefits for human consumption, was given high priority by AQD. Once the nutritional requirements of important tropical aquaculture species were established and after taking into account their requirements for protein, lipids, carbohydrates, essential fatty acids and amino acids, as well as for some vitamins and minerals, AQD developed complete diets for all life stages (larval, nursery, grow-out and broodstock) of selected economically-important aquaculture species of crustaceans (shrimps and crabs) and fish. Meanwhile, AQD's quest for suitable alternative protein sources for the production of cost-effective practical diets continued in order to divert the dependence of aquafeed industries on fish meal and other fish-based products, and pull them out from the so-called "fish meal trap". This was also meant to steer the direction of AQD towards the promotion of aquaculture for rural development, as called for in the 2001 Resolution and Plan of Action for Food Security for the ASEAN Region (SEAFDEC, 2001). While the nutrient characteristics of alternative feed ingredients were enhanced through biotechnology, AQD revolutionized feeds and feeding management for reduced pollution in aquafarms as well as in effluents (Platon, *et al.*, 2007).

Anchored on arguments that mangroves and aquaculture can co-exist (Aldon, *et al.*, 2008) as well as on the conditions prescribed by Primavera (2004) for effective co-existent to mangroves and aquaculture, and on the premise that mangroves provide a wide array of goods and services from forestry and fisheries (Primavera, 2004a), AQD embarked on a mangrove aquasilviculture project aimed to develop or verify culture technologies that are

compatible with mangroves, which could be incorporated in overall mangrove conservation and rehabilitation programs. AQD's research focused on the aquasilviculture of various commodities such as milkfish, shrimps and mud crabs; assessment of the capability of mangroves to absorb nutrients; population, biological and ecological studies of mangrove-associated fauna; and the impacts of aquaculture on mangroves and fisheries.

Consistent with its desire to enhance the sustainability of aquaculture for rural development, AQD worked out the culture techniques of various phytoplankton and zooplankton that could be used as live feeds for the larvae of fishes, crabs, abalone and shrimps in the hatchery, to minimize dependence on imported brine shrimps which is very costly. The techniques established for the mass propagation of phytoplankton (*Chaetoceros calcitrans*, *Skeletonema costatum*, *Isochrysis galbana*, *Nannochlorum* sp., *Tetraselmis tetrahele*, *Navicula ramosissima*, *Amphora* sp., *Anabaena* spp., *Spirulina platensis*) and zooplankton (rotifers such as *Brachionus rotundiformis*; cladocerans such as *Moina macrocopa*, *Diaphanosoma celebensis*; and copepods such as *Tisbintra* spp., *Acartia* spp., *Pseudodiaptomus* sp.) had been disseminated to stakeholders through training and information dissemination activities.

Looking at the Present to Orchestrate Aquaculture Development

After the adoption of the Resolution and Plan of Action for Food Security for the ASEAN Region in June 2001, these instruments had been used by AQD as policy framework for the promotion of sustainable aquaculture development in the Southeast Asian region (Toledo *et al.*, 2011). Almost ten years later in 2010, AQD convened the Regional Technical Consultation for Sustainable Aquaculture Development of Southeast Asia Towards 2020 in Bangkok, Thailand in March 2010 to assess the implementation of the 2001 Resolution and Plan of Action under the various aspects of aquaculture and determine the issues that constrain the sustainable development of aquaculture in the Southeast



Box 2. Thrust of AQD's R&D towards 2020

Meeting social and economic challenges of aquaculture in Southeast Asia: Ten years into the 21st century, aquaculture remains confronted with issues on equity in terms of opportunities and the distribution of benefits that fall short in addressing food security and livelihood of small-scale sector stakeholders. This requires crafting programs that could address the social and economic challenges in the promotion of rural or small-scale holder aquaculture (Salayo, 2012). More specifically, the issues that need urgent attention include: capacity building, access to capital as well as markets, policies and governance, and avenues for aquaculture as an option for improving resilience of fish farmers and fishers to the impacts of climate change. Therefore, AQD will exert efforts to address such concerns by: (i) enhancing the role of aquaculture in improving the livelihood and food security at all levels (local, national and regional); (ii) supporting the sustainability of the environment and resources; and (iii) identifying relevant policies, infrastructure and linkages that will better equip the Southeast Asian countries in meeting the socio-economic challenges in the next ten years.

Quality seed production for sustainable aquaculture: In spite of recent advancements in selective breeding and seed production technologies for aquaculture commodities and the availability of genetically-improved aquaculture strains, there remains a pressing need to improve seed quality and yield for sustainable aquaculture in the Southeast Asian region (Romana-Eguia, 2012). AQD will therefore continue to enhance the reliable supply of better quality seedstock through the development of action plan that would address the research and development needs associated with the environmental and genetic requisites for better quality seeds, facilitate the maintenance and dissemination/distribution of improved stocks including access by a wide range of farmers to and marketing of quality seeds.

Healthy and wholesome aquaculture: R&D efforts in aquaculture have resulted in phenomenal growth of the sector during the last four decades, but it is being confronted with more problems that need to be addressed in order to assure its sustainability for future generations (Coloso, 2012). Moreover, there is certainty that in the next decade, practices which threaten food safety and concerns relating to the impact of aquaculture on the ecosystem will continue. AQD has been promoting the concept of wholesome and healthy aquaculture as a holistic approach to fish disease management as well as development of cost-effective feeds that optimize the production of robust and healthy farmed aquatic commodities with the least negative impact of the environment. AQD will continue its R&D in fish nutrition and fish disease management to ensure a steady and reliable supply of safe and quality fish beneficial to the public, as well as enhance the capacity and affordability of adopting such practices by a wide range of small-scale farmers.

Maintaining environmental integrity through responsible aquaculture: Despite the significant progress made by SEAFDEC in the regionalization and promotion of the Code of Conduct for Responsible Fisheries, the aquaculture sector in the region is still confronted with issues related to environmental protection and wise use of resources (de Jesus-Ayson and Gallardo, 2012). Therefore, there is a need to continue the environmental monitoring of water and sediment quality associated with ponds, net cages, and pens to ensure productivity and sustainability as well as minimizing the adverse impacts of and adaptations to climate change. AQD will address the research needs and develop strategic actions that will aim to promote the environmental sustainability of aquaculture in the region.

Adapting to climate change impacts: Climate change is a compounding threat to the sustainability of aquaculture development. Impacts occur as a result of gradual warming, the increasing acidity of the oceans and associated physical and chemical changes. How these changes affect the aquaculture organisms in general, the different aquaculture systems and structures, the various support systems to aquaculture operations, and to the fish farmers, are largely unknown. Fish farmers and the general public will need to have better understanding about climate change and its likely impact(s) to their livelihood opportunities for better preparation and adaptation. Since largely almost nothing is known how climate change will affect the biology of various species presently farmed and the various support systems, AQD will generate important data on this aspect to serve as basis for the mitigation measures that will be provided. How climate change affects important related ecosystems like the mangrove and coral reef ecosystems will be ascertained as well.

Asian region. Recommendations from the Consultation were used as basis for defining the next decade's strategies for the sustainable development of aquaculture in the region, where addressing the challenges that confront the small-scale aquafarmers operating the region's aquaculture farms, which are mostly small-scale, was emphasized. These included the need to: (i) meet social and economic challenges of Southeast Asian aquaculture; (ii) produce quality seeds for sustainable aquaculture; (iii) promote healthy and wholesome aquaculture; (iv) maintain environmental integrity through responsible aquaculture; and (v) protect the environment and adapt to the impacts of climate change (Acosta *et al.*, 2011).

As AQD now enters into the threshold of its ruby jubilee on 9 July 2013, it aspires to adhere to the roadmap for sustainable aquaculture development with much passion reflecting the fiery red of the gemstone ruby. Therefore, while sustaining the implementation of research, technology verification and demonstration, and training and information activities based on the priorities and needs of the Member Countries, AQD intends to aggressively push forward the sustainable

development of aquaculture in Southeast Asia through the: (i) development of responsible aquaculture technologies and practices; (ii) responsible use of aquatic resources for the purpose of aquaculture; (iii) adoption of measures to avoid environmental degradation; and (iv) the promotion of environmentally-sound aquaculture methods and commodities. Using the subsequent 2011 Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2020 (SEAFDEC, 2011) as basis to re-craft its new direction, AQD will put more emphasis on the formulation of strategies that will help meet the current and emerging socio-economic challenges of aquaculture in Southeast Asia. For the next decade, AQD will therefore focus its future R&D thrust on five major concerns summarized in (Box 2). Nonetheless, AQD will also sustain the systematic packaging of its research results into commercially-viable aquaculture technologies and production systems for dissemination as means of enhancing its services to the private sector and the fishery industry as a whole, and will continue to provide technical assistance to the Member Countries in starting up or in the adoption of new technologies.

In addition, while following up on the need to address various aquaculture concerns as stipulated in the 2011 Resolution and Plan of Action, AQD has re-directed its pace towards the fundamental steps of improving livelihood and alleviating poverty in rural communities. One of the approaches embarked by AQD is the Program on Meeting Social and Economic Challenges in Aquaculture or MSECAP (Salayo *et al.*, 2012), which is aimed at developing and implementing social and economic strategies in aquaculture and resource management to secure food and incomes of the peoples in Southeast Asia, as well as alleviate poverty in rural communities. The strategies outlined in MSECAP include the implementation of R&D activities that explore the participatory and community-based modality in the promotion of aquaculture technologies in rural communities.

As planned, MSECAP is expected to deliver results that will converge towards developing prototype aquaculture technology adoption pathways that would satisfy the social and economic needs of the peoples in the Southeast Asian region. This approach is also in accordance with the recommendations clearly expressed during the 2011 ASEAN-SEAFDEC Conference (SEAFDEC, 2012).

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