Orchestrating the Southeast Asian Aquaculture towards Sustainability: SEAFDEC Initiative

Chumnarn Pongsri, Felix G. Ayson, Virgilia T. Sulit, Belen O. Acosta, and *Nualanong Tongdee*

Three years after the Philippines became a signatory to the Agreement Establishing the Southeast Asian Fisheries Development Center (SEAFDEC) in January 1968, the Philippine Government submitted a Position Paper during the Fourth Meeting of the SEAFDEC Council in January 1971, formally inviting SEAFDEC to establish a regional aquaculture project in the Philippines. This was anchored on the decision reached during the Third Ministerial Conference for the Economic Development of Southeast Asia in 1968, for SEAFDEC to consider the establishment of a new department to deal with freshwater and brackishwater fish culture, in addition to the already established Research and Training Departments. Subsequently, the Ministerial Conference established a working group of aquaculture experts from the Member Countries to conduct a study on the aquaculture situation in Southeast Asia. Their report which indicated that the new SEAFDEC Department could be established in the Philippines was considered by the Fourth Ministerial Conference for the Economic Development of Southeast Asia in 1969. This led to the series of surveys in the Philippines, conducted by a Survey Mission from the Japanese Overseas Technical Cooperation Agency headed by Dr. Katsuzo Kuronoma, former President of Tokyo University of Fisheries, Japan from 1969 to 1971 to identify the appropriate site of this new Department. Together with counterpart experts from the Philippines, the Survey Mission concluded that the Aquaculture Department would be established in Iloilo Province, Panay Island, Philippines, to undertake aquaculture research in the region, and training of researchers and technicians in aquaculture. Following a conference in September 1972 among representatives from the Philippines and Japan, the Mindanao State University which at that time had already developed the technology for breeding penaeid shrimps, was designated as implementing agency of the Project for the Philippine Government. Although shrimp culture was given priority in the initial project plan, it was also agreed that the new Department could undertake, whenever feasible, the culture of other coastal and brackishwater species, and in a subsequent stage, freshwater fish culture. Based on such recommendations and the commitments of the Governments of Japan and the Philippines to support the operations of the new SEAFDEC Department, the Sixth Meeting of the SEAFDEC Council in July 1973 in Kuala Lumpur, Malaysia agreed to establish the Aquaculture Department in Iloilo, Philippines, adopted the corresponding Plan of Operation and Program of Work, and approved the appointment of Dean Domiciano K. Villaluz as the first Department Chief. True to its word, the Aquaculture Department has since then been pursuing programs on sustainable development and responsible stewardship of aquaculture resources in Southeast Asia through research and promotion of appropriate aquaculture technologies and socio-economic strategies relevant to the sustainability of the aquaculture industry in the region.

Since its establishment in 1973, the Aquaculture Department (AQD) of SEAFDEC has continued to carry out research, technology generation, training, and information dissemination activities on a wide range of aquaculture disciplines, *i.e.* management of broodstock and seed quality improvement, promotion of responsible and environment-friendly aquaculture, disease diagnosis, prevention and control, and aquaculture for stock enhancement of threatened species. These activities cover various aquatic commodities, *e.g.* milkfish, groupers, Asian sea bass, snappers, siganids, pompano, bighead carp, catfish, tilapia, tiger shrimp, other penaeid shrimps, freshwater prawn, mud crab, blue swimming crab, abalone, sea cucumber, seahorse, oysters, mussels, seaweeds, Napoleon wrasse, and others. AQD also promotes good aquaculture practices and effective management of aquatic resources to support rural development and alleviate poverty. Being in the forefront of harnessing the aquaculture potentials in the Southeast Asian region, AQD makes sure that its programs and activities address the requirements and priorities of the ASEAN Member States (AMSs) towards sustainable aquaculture development. Specifically, in carrying out its programs and activities, AQD sets its sights on ensuring that the region's aquaculture operations are technologically feasible, responsibly producing safe and quality aquaculture products, socially and economically viable, and environmentally sound, in accordance with the provisions on aquaculture in the Resolution and Plan of Action that were adopted by the ASEAN Members States in 2001 and its superseding Resolution and Plan of Action adopted in 2011. In the Southeast Asian region, aquaculture is categorized into mariculture, brackishwater culture, and freshwater culture.

Aquaculture Development in Southeast Asia

Although fish farming in Southeast Asia has been considered as an age-old practice, it was only in the early 70s that it became an industry in Southeast Asia when many countries picked up the rudiments of aquaculture operations. Reports have indicated that freshwater aquaculture in Southeast Asia might have started with what is now known as rice-

Bountiful harvest of milkfish in the Philippines

fish culture which is actually an extension of rice farming in paddies and where fish that migrate through canals and refuge are raised to commercial size. Nonetheless, freshwater fish culture could already be considered an industry in many countries in Southeast Asia, *e.g.* Thailand, Cambodia, Myanmar, Lao PDR, Viet Nam, considering that technologies for freshwater fish breeding had already been developed and freshwater fish seeds are available for culture in inland water bodies.

In other countries, such as Indonesia and the Philippines, brackishwater aquaculture had always been practiced for centuries, with milkfish as the main species being cultured. Production of penaeid shrimps had its humble beginnings when early milkfish ponds also yielded shrimps as by-products. Subsequently, shrimp culture developed into an industry when shrimps, especially the tiger shrimp (*Penaeus monodon*) started to command high prices while demand in international markets continued to rise. Meanwhile, mariculture in Southeast Asia could be considered a late bloomer, being introduced to culture other marine aquatic species away from land areas that had become scarce due to land conversion for the sake of development. Nonetheless, records have also shown that the culture of marine species, *e.g.* oysters and seaweeds, is an ancient practice in many regions of the world.

Aquaculture has greatly expanded when scientists established the life cycles of many "culturable" aquatic species that led to the development of fish culture technologies, *i.e.* breeding, feeding and fish health management, among others. Starting with carps, tilapia, bivalves, milkfish, and the luxury item penaeid shrimps as the most common aquaculture produce, the trend changes as new technologies for the culture of other marine species were developed, leading to the production of other aquatic species that serve as source of protein for local fisherfolks and additional foreign exchange earnings for the countries.

Since the start of the commercialization of aquaculture in Southeast Asia in early 70s, cultured fish production has been steadily rising during the first two decades accounting for about 11% of the region's total fisheries production in terms of volume and 23% in terms of value annually. In the second decade starting mid 90s until mid 2000s when aquaculture technologies had been improved and responsible aquaculture was promoted in Southeast Asia, production from aquaculture sharply increased, annually contributing about 31% to the region's total production from fisheries in terms of volume and 44% in terms of value (**Table 1**).

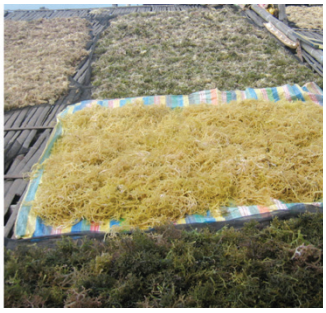
Specifically during the past ten years from 2003 to 2012, the aquaculture sector of the Southeast Asian region annually contributed an average of about 21% to the world's aquaculture production, and 8% to the world's fish production (**Table 2**). While mariculture contributed an average of 42% annually to the region's total aquaculture production, freshwater culture had been following closely at 38% and brackishwater culture at 20% (**Table 3**). The increasing volume of production from mariculture has been brought about by increased production of seaweeds in Indonesia and the Philippines while that of freshwater culture was due to increases in the production of pangas catfish and miscellaneous freshwater fishes by Viet Nam starting in 2010.

Table 1. Trend of fisheries and aquaculture production in Southeast Asia (1974-2012)*:
Quantity in 1000 metric tons (MT); Value in 1,000,000 US$

	1974-1978	1979-1983	1984-1988	1989-1993	1994-1998	1999-2003	2004-2008	2009-2012
Total Fisheries Production of Southeast Asian (five-year averages)								
Quantity	6,395.1	7,457.9	8,809.7	11,024.4	14,208.9	17,983.3	24,159.8	33,352.6
Value	2,567.1	4,127.3	4,361.5	5,307.0	8,244.9	11,802.8	19,910.6	39,175.3
Aquaculture Production of Southeast Asia (five-year averages)								
Quantity	483.2	718.5	1,069.2	1,628.0	2,320.2	4,272.6	8,452.9	15,869.5
Value	318.9	771.5	975.2	1,913.1	3,367.6	4,912.6	9,494.1	17,678.7

Sources: SEAFDEC (1980), SEAFDEC (1984), SEAFDEC (1987), SEAFDEC (1992), SEAFDEC (1994), SEAFDEC (1997), SEAFDEC (2002), SEAFDEC (2006), SEAFDEC (2010), SEAFDEC (2014)

** Five-year averages of aquaculture production from Southeast Asian countries (Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Viet Nam)*



Seaweed harvest in the Philippines

The major commodities in freshwater culture comprise mainly carps, barbs and other cyprinids, tilapias, catfishes and miscellaneous freshwater fishes, produced by Indonesia, Myanmar, Thailand, and Viet Nam, while penaeid shrimps, *e.g.* tiger shrimp, vannamei shrimp, and other penaeids (**Table 3**) comprised the major commodities produced from brackishwater culture, notably by Indonesia, Philippines, Thailand and Viet Nam. Mariculture has always been dominated by seaweeds produced by Indonesia and the Philippines.

Table 2. Southeast Asia's aquaculture production *vs.* world's total fisheries production (units in million metric tons)

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Total fisheries production: World*	132.2	134.3	136.4	137.1	140.7	143.1	145.8	148.1	155.7	158.0
Total aquaculture production: World*	41.9	41.9	44.3	47.4	49.9	52.9	55.7	59.0	62.0	66.6
Total fisheries production: Southeast Asia**	20.2	21.1	22.9	24.4	25.2	27.3	28.9	31.4	33.5	39.6
Total aquaculture production: Southeast Asia**	5.4	6.2	7.4	8.4	9.2	11.1	12.4	14.2	15.8	21.2

** Sources: FAO (2004), FAO (2010), FAO (2014)*
*** Sources: SEAFDEC (2005), SEAFDEC (2010), SEAFDEC (2014)*

Table 3. Ten-year trend of the volume of Southeast Asia's aquaculture production* (units in million metric tons)

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Volume Total aquaculture production	**5.4**	**6.2**	**7.4**	**8.4**	**9.2**	**11.1**	**12.4**	**14.2**	**15.8**	**21.2**
Mariculture	**2.2**	**2.7**	**3.0**	**3.6**	**3.8**	**4.7**	**5.0**	**5.9**	**7.1**	**8.5**
Seaweeds	1.3	2.0	2.3	2.9	3.1	2.1	4.3	5.3	6.4	7.8
Sea mussels	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.2	0.2	0.2
Blood cockles	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1
Misc. marine molluscs			0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1
Others	0.4	0.2	0.1	0.1	0.1	2.1	0.1	0.1	0.3	0.3
Brackishwater culture	**1.2**	**1.5**	**1.9**	**1.9**	**2.1**	**2.1**	**2.7**	**2.5**	**2.6**	**2.7**
Milkfish	0.4	0.5	0.5	0.5	0.5	0.3	0.4	0.7	0.7	0.8
Tiger shrimp	0.4	0.5	0.6	0.4	0.4	0.5	0.4	0.3	0.2	0.2
Vannamei shrimp	0.1					0.8	0.6	0.8	0.7	0.8
Other penaeid shrimps		0.3	0.4	0.6	0.6	0.3	0.6	0.1	0.1	
Misc. marine fishes					0.2		0.6	0.1	0.2	
Gracilaria seaweeds								0.4	0.6	0.8
Others	0.3	0.2	0.4	0.4	0.4	0.2	0.1	0.1	0.1	0.1
Freshwater culture	**2.0**	**2.0**	**2.5**	**2.9**	**3.3**	**4.3**	**4.7**	**5.8**	**6.1**	**10.0**
Cyprinids	0.6	0.6	0.3	0.5	0.4	0.7	0.2	0.9	0.6	3.8
Tilapias	0.4	0.4	0.5	0.5	0.6	0.6	0.6	1.8	1.1	1.2
Catfishes	0.3	0.3	0.7	0.8		0.2	0.2	0.5	0.6	0.6
Pangas catfish					1.2	1.5	1.1	0.4	0.3	0.4
Misc. freshwater fishes		0.3	0.9	1.0	0.9	0.6	2.0	0.9	2.9	2.9
Roho labeo						0.4		1.0	0.6	0.6
Others	0.7	0.4	0.1	0.1	0.2	0.3	0.6	0.3		0.5

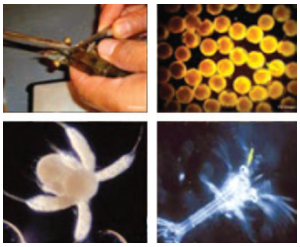
**Sources: SEAFDEC (2005), SEAFDEC (2010), SEAFDEC (2014)*

Table 4. Ten-year trend of the value of Southeast Asia's aquaculture production* (units in million US$)

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Value of total aquaculture production	**5.9**	**7.2**	**7.7**	**7.2**	**12.8**	**14.0**	**16.0**	**13.4**	**19.7**	**21.7**
Mariculture	**1.6**	**0.6**	**1.3**	**1.9**	**0.9**	**3.0**	**2.2**	**2.7**	**1.8**	**2.9**
Seaweeds	0.1	0.2	0.3	0.3	0.5	1.3	1.0	1.4	1.2	2.0
Misc. marine molluscs	0.2	0.2	0.7	0.9	0.2	0.2	0.4	1.0	0.2	0.2
Others	1.3	0.2	0.3	0.7	0.2	1.5	0.8	0.3	0.4	0.7
Brackishwater culture	**2.9**	**4.6**	**4.6**	**4.0**	**6.0**	**5.7**	**7.2**	**6.5**	**6.1**	**6.1**
Milkfish	0.4	0.5	0.5	0.5	0.6	0.5	0.5	1.4	1.2	1.3
Tiger shrimp	1.8	2.3	2.2	1.3	2.0	1.4	1.8	1.6	1.2	1.3
Vannamei shrimp	0.3					0.2	1.8	3.0	2.4	3.3
Other penaeid shrimps		1.7	1.7	1.9	1.8	1.7	0.4	0.4	0.4	
Misc. marine fishes				0.1	0.3	0.4	1.9		0.4	
Others	0.4	0.1	0.2	0.2	1.3	1.5	0.8	0.1	0.5	0.2
Freshwater culture	**1.4**	**2.0**	**1.8**	**1.3**	**5.9**	**5.3**	**6.6**	**4.2**	**11.8**	**12.7**
Cyprinids	0.3	0.2	0.2	0.2	0.8	0.5	0.2	0.5	2.2	2.4
Tilapias	0.3	0.4	0.4	0.5	0.5	0.3	0.7	1.1	2.2	2.7
Catfishes	0.2	0.4	0.4	0.3	1.5		0.3		1.4	1.6
Pangas catfish						1.9	1.6	0.3	1.1	1.3
Misc. freshwater fishes		0.6	0.6	0.1	1.9	2.2	3.1	1.6	4.6	2.5
Roho labeo						0.3	0.4	0.5	0.2	1.8
Others	0.6	0.4	0.2	0.2	1.2	0.1	0.3	0.2	0.1	0.4

Sources: SEAFDEC (2005), SEAFDEC (2010), SEAFDEC (2014)

In terms of the value of the region's aquaculture production during the last ten years (2003-2012), the highest contribution came from brackishwater culture at an annual average of 43%, closely followed by freshwater culture at 42%, and mariculture at 15% (**Table 4**). The increasing value of production from brackishwater culture had been brought about by increases in the value of penaeid shrimps, more particularly the vannamei shrimp, while that of freshwater culture was due to the increasing value of tilapias and miscellaneous freshwater fishes and the *pangas* catfish.



Role of SEAFDEC in the Sustainable Development of Aquaculture in Southeast Asia

Development of the aquaculture sector in Southeast Asia has always been in accord with the progress made by the SEAFDEC Aquaculture Department (AQD) in terms of aquaculture technology generation (SEAFDEC Aquaculture Department, 2013). AQD's R&D in shrimp culture, notably the giant tiger shrimp (*Penaeus monodon*), started in early 1970s immediately after its establishment and is therefore as old as AQD itself. As AQD continued to reap successes in its innovative works on the biology, broodstock management and maturation of the tiger shrimp, its outputs had been disseminated and were subsequently picked up by the

countries contributing largely to the development of shrimp breeding in the region.

Results of AQD's studies on shrimp nutrition, health management and grow-out culture have also been adapted by the countries for their advancing shrimp industry. As a result, Southeast Asia's shrimp aquaculture sub-sector is now one of the highest producers of shrimps for the world market, contributing about 17% to the world's total production from farmed crustaceans (FAO, 2014). In the Southeast Asian scene, shrimp aquaculture in 2012 accounted for about 5% of the total aquaculture production volume and about 21% in terms of value (SEAFDEC, 2014).

AQD's achievements in milkfish aquaculture started during the late 70s with the closing of the life cycle of milkfish (*Chanos chanos* Forsskal). The pioneering studies of AQD on reproduction, larval biology and nutritional requirements of milkfish led to the 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 has served as model for improved culture technologies which could be adapted for the culture of various commodities in most countries of the region.

The common practice of using wild crablets in mud crab aquaculture, 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.

The success of AQD in completing the life cycle of abalone in captivity has led to the promotion of the responsible culture of the donkey's ear abalone (*Haliotis asinina*). Technologies developed by AQD for mass seed production, feed formulations and feeding management for juveniles, grow-out culture in floating cages, sea ranching and stock enhancement, had been pilot-tested with the private sector. These technologies are now being disseminated through training courses on abalone offered annually by AQD.

After the establishment of its Binangonan Freshwater Station near Laguna Lake in northern Philippines in 1976, AQD embarked on freshwater aquaculture R&D focusing on the Nile and red tilapias, bighead carp, native clariid catfish, and freshwater prawn. Since then, breeding and seed production techniques, feed formulations, farm-based genetic selection schemes have been developed, and disseminated to aquafarmers in the region through AQD's training and information activities. AQD is also pursuing a research on indigenous freshwater fishes like the silver therapon and climbing perch for sustainable aquaculture and biodiversity conservation.

The high demand for live reef food fish in the world market due to the health benefits of eating fish has led to brisk expansion of live reef food fish trade (LRFFT), especially in Asia. In response to concern over possible over-exploitation of the reef fishes, AQD developed the technologies for captive breeding, hatchery and 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 is expected to 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 fish farmers in the Southeast Asian region.

In an effort to sustain production of seaweeds as top export commodity of the Southeast Asian region, AQD mobilized its expertise to maintain the competitiveness of the region's seaweed industry in the world market. Focus was therefore placed in improving the farming technology of *Kappaphycus* spp. and *Gracilaria* spp., and developing new and better-performing (in terms of growth and resistance to ice-ice disease) strains of *Kappaphycus* spp. Farming of these commercially important red seaweeds could provide alternative livelihood to poor fishers and coastal dwellers in the Southeast Asian countries.

In the early 2000s, AQD initiated the genetic improvement of the giant freshwater prawn *Macrobrachium rosenbergii*

with the cooperation of research institutions in Thailand and Indonesia. As a result, seed production studies have improved the survival in the hatchery by up to 70% while AQD was able to successfully develop lake-based cage culture technology, now being transferred to stakeholders in the region through AQD's training and information dissemination activities.

After AQD developed the hanging raft method for mussel and oyster culture, it has been promoted to fish farmers because such technique is not only environment-friendly but also results in better growth and gives higher financial returns. For *Placuna placenta*, AQD developed the sustainable broodstock management and spawning techniques, and juvenile production in hatcheries with the objective of replenishing depleted natural stocks. Although locally adopted, results of AQD's initiative in the restocking of this shell along the Panay Gulf in western Philippines starting in the late 90s resulted in recruitment and bountiful harvest ten years later.

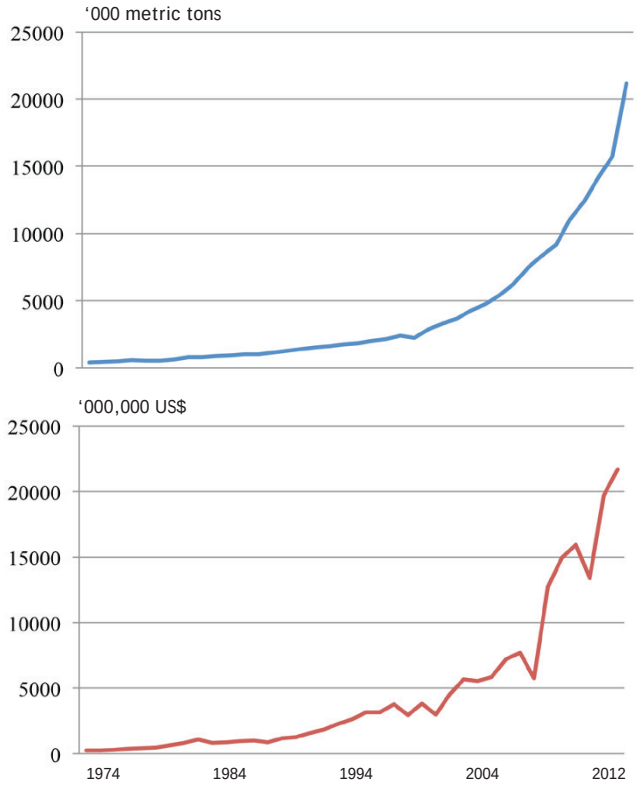


Fig. 1. Trend of aquaculture production of Southeast Asia (1974-2012): volume (*above*) and value (*below*)

The efforts of AQD in its R&D had paid off as aquaculture production continued to increase not only in terms of production but also in terms of value, as shown in **Table 1** and **Fig. 1**. More specifically, starting in the early 2000s, production from aquaculture attained drastic increases at an annual average rate of 14%. It was also during this period that SEAFDEC regionalized the FAO Code of Conduct for Responsible Fisheries (CCRF): Responsible Aquaculture. Thus, the Regional Guidelines for Responsible Fisheries in Southeast Asia: Responsible Aquaculture (SEAFDEC, 2005a), which has since then been promoted in the Southeast Asian region, ensures that the Southeast Asian

countries' aquaculture operations are done in responsible and environment-friendly manner.

Way Forward

While SEAFDEC/AQD has continued to prosper in its R&D efforts over the past 42 years based on its mandates, it is also setting its sights in supporting the growth of aquaculture sector in the region through development and transfer of responsible and sustainable aquaculture technologies and practices and strengthening the capacities of the aquaculture sector to enhance technology transfer. To steer AQD towards achieving these long-term objectives and a vision of becoming a global leader in the generation and transfer of appropriate and sustainable tropical aquaculture technologies for food security and holistic human development, AQD would continue to conduct activities that would address these objectives: (i) generate, verify and promote technologies to ensure sustainable production of quality seedstock for aquaculture and stock enhancement; (ii) improve aquaculture production through innovations in nutrition and feeding and fish health management in aquaculture and in maintaining the environmental integrity of aquaculture; (iii) develop environment friendly-based aquaculture technologies by integrating environmental factors with the overall effort of AQD in promoting responsible aquaculture; (iv) identify research approaches that could help the region's aquaculture sector adapt to the impacts of climate change; and (v) develop and implement social and economic strategies in aquaculture and resource enhancement to secure food and incomes of the region's populace as well as alleviate the rural communities through stakeholder collaboration.

Now that AQD is entering the threshold of its golden decade, it would place more emphasis on addressing the above-mentioned objectives and other emerging needs and priorities of the Southeast Asian countries. This will be done through the development and accelerated transfer of appropriate technologies anchored on solid R&D and in accordance with its mandate. Overall, these strategies are expected to dovetail towards attaining the sustainability of the aquaculture industry in Southeast Asia.

References

FAO. 2014. The State of the World Fisheries and Aquaculture: Opportunities and Challenges. Food and Agriculture Organization of the United Nations, Rome, Italy; 223 p

SEAFDEC Aquaculture Department. 2013. Reducing Rural Poverty and Improving Lives through Sustainable Aquaculture: AQD's 40-year Saga of Mustering Strength and Expertise for Technology Development. ***In***: Fish for the People, Volume 11, Number 2 (2013). Southeast Asian Fisheries Development Center, Bangkok, Thailand; pp 42-47

SEAFDEC. 1980. Fishery Statistical Bulletin for South China Sea Area 1978. Southeast Asian Fisheries Development Center, Bangkok, Thailand; 200 p

SEAFDEC. 1984. Fishery Statistical Bulletin for South China Sea Area 1982. Southeast Asian Fisheries Development Center, Bangkok, Thailand; 268 p

SEAFDEC. 1987. Fishery Statistical Bulletin for South China Sea Area 1985. Southeast Asian Fisheries Development Center, Bangkok, Thailand; 178 p

SEAFDEC. 1992. Fishery Statistical Bulletin for South China Sea Area 1989. Southeast Asian Fisheries Development Center, Bangkok, Thailand; 169 p

SEAFDEC. 1994. Fishery Statistical Bulletin for South China Sea Area 1992. Southeast Asian Fisheries Development Center, Bangkok, Thailand; 159 p

SEAFDEC. 1997. Fishery Statistical Bulletin for South China Sea Area 1994. Southeast Asian Fisheries Development Center, Bangkok, Thailand; 159 p

SEAFDEC. 2002. Fishery Statistical Bulletin for South China Sea Area 1998. Southeast Asian Fisheries Development Center, Bangkok, Thailand; 142 p

SEAFDEC. 2005. Fishery Statistical Bulletin for the South China Sea Area 1999-2001. Southeast Asian Fisheries Development Center, Bangkok, Thailand; III-183 p

SEAFDEC. 2005a. Regional Guidelines for Responsible Fisheries in Southeast Asia: Responsible Aquaculture. Aquaculture Department, Southeast Asian Fisheries Development Center, Tigbauan, Iloilo, Philippines; 42 p

SEAFDEC. 2010. Fishery Statistical Bulletin of Southeast Asia 2008. Southeast Asian Fisheries Development Center, Bangkok, Thailand; 135 p

SEAFDEC. 2014. Fishery Statistical Bulletin of Southeast Asia 2012. Southeast Asian Fisheries Development Center, Bangkok, Thailand; 135 p

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