



PROJECT DOCUMENT

ACHIEVEMENTS FOR YEAR 2019

Project ID: 201503002			
Program Category	ASEAN-SEAFDEC ASSP and FCG Mechanism		
Project Title	Environment-friendly, Sustainable Utilization and Management of Fisheries and Aquaculture Resources		
Program Strategy No.	II	Total Duration	2015 - 2019
Lead Department	Aquaculture Department (AQD)	Lead Country	None
Donor/Sponsor	Japanese Trust Funds (JTF)	Total Donor Budget	USD 417,420
Project Partner	None	Budget for 2019	USD 64,540
Project Leader	Koh-ichiro Mori / AQD	Project Participating Country (ies)	ALL Member Countries

PART I: OVERALL PROJECT DESCRIPTION

1. Brief Project Description:

The Project titled “Environment-friendly, sustainable utilization and management of fisheries and aquaculture resources” was proposed to:

1) Establish environment-friendly, responsible aquaculture technology

Nature-conscious culture technologies guaranteeing environment-friendliness.

- Use of plant-origin feed ingredients that are available in the region will be explored in the development and/or refinement of aquafeed for cultured freshwater fish species such as tilapia
- Ecosystem-based pond management strategies will be developed using shrimp, mud crab, milkfish, etc. as the target culture species through aquasilviculture.

2) Promote community-based production and resource enhancement of high-value aquatic resources

- Community-based integrated production of abalone *Haliotis asinina* and sea cucumber *Holothuria scabra* through culture, sea ranching and stock enhancement is proposed for low-income households who live in environments without electricity but with natural food for abalones and sea cucumbers. Seeds will be produced in small-scale solar-powered hatchery.
- Development of technologies on appropriate transport and acclimation strategies of seahorses from the hatchery to the release site; to determine the appropriate size of seahorses for release as well as the appropriate time of release; to develop appropriate monitoring strategies of the released seahorses; and to establish a community-based hatchery for seahorses.

3) Disseminate and demonstrate resource enhancement practices.

- Extension and demonstration for the breeding, hatchery seed production, nutrition and health management in grouper, sea bass, snapper, etc. through training program. Special training focusing on the culture of important fisheries commodities such as giant freshwater prawn, cat fish, big head carp.

2. Background and Justification:

Among increasing demand for food due to rapid increase of world population, aquatic food production has been increasing steadily (FAO, 2012). However, capture production has attained the

saturation levels and been stagnated since mid-1990s, and this shows that the importance of aquaculture is ever growing in these decades and in the future. In 2010, 47 % of the total production was supported by culture production. Nowadays, culture production in Asia accounts for 91.5 % of the world production. In 2010, four SEAFDEC Member Countries (MCs), which is, Indonesia, Vietnam, Philippines, and Thailand, were included in the top ten countries in the world. Indeed, the remarkable increase in aquaculture was more pronounced in the Southeast Asian region compared to the world as shown in the increase of culture production in 2010 compared to that in 2001, showing 3.52 versus 1.78 times, respectively.

On the other hand, the rapid growth in aquaculture also brought negative impacts into our region such as: degradation of the culture sites, destruction of sensitive ecosystems, decrease in bio-diversity, spread of diseases, social conflicts, etc. All of them hinder sustainability of the aquatic food production. Majority of the repercussions which affect not only stabilities of culture production but also stock levels of wild aquatic species, particularly, have been amplified by paucities of consideration on impact of intense anthropological pressures on natural environments and resources, which also preclude efforts towards food security and poverty alleviation in the region. These undesirable ramifications would not happen if the responsible utilization and management were correctly and appropriately practiced.

Among the countermeasures to address the environmental and social issues arising from fisheries and aquaculture practices, active approaches for establishment of environment-friendly culture technologies, promotion of community-based management of aquatic resources and replenishment of endangered species are becoming increasingly significant to secure the sustainable utilization and management of aquatic species in our region. So far, the Aquaculture Department of Southeast Asian Fisheries Development Center (SEAFDEC/AQD) has acquired useful information and developed skills especially in the fields of feed development, culture technology with mangrove forests, and community-based management for aquatic species production under the regional program “Promotion of sustainable aquaculture and resource enhancement in Southeast Asia” funded by the Government of Japan Trust Fund-V (JTF5) in 2010-2014. However, the said activities should be further strengthened so that the sustainable utilization and management of aquatic resources will be accomplished in responsible manners in the Southeast Asian region. Varieties of endeavour to diminish or take away the negative factors are also required at once in such activities. On the other hand, approaches towards issues on the internationally over-exploited species are still primitive and should be firmly addressed. Particularly, to be correctly justified with the international trade regulations, we need to hurry to establish management protocols and technologies to secure the sustainable utilization under the appropriate conservation.

SEAFDEC has continuously been trying to contribute to food security and poverty alleviation. Environment-friendly, sustainable utilization and management of aquatic resources would be the just wholesome practices towards these goals.

3. Project Overall Objectives, Outcomes, Outputs, Indicators and Activities:

3.1 Objectives, Outcome and Output of the Project

Objective	Outcomes	Outputs	Activities
Objective 1: To establish environment-friendly, responsible aquaculture technology	Outcome 1: Use of plant-origin feed ingredients that are available in the region for cultured	Output 1: Exploration of plant-origin feed ingredients that are available in the region for cultured	Activity 1: Establishment of environment-friendly, responsible aquaculture technology ➤ The replacement of fishmeal as the main source of protein in feeds that will further improve production traits of tilapia.

	<p>freshwater fish species such as tilapia.</p> <p>Promoting the aquasilviculture of shrimp as an ecosystem based management strategy</p>	<p>freshwater fish species such as tilapia.</p> <p>Establishment of ecosystem-based pond management strategies for increased production in ASEAN member countries.</p>	<ul style="list-style-type: none"> ➤ Test of refined formulated diets in cages and pond culture systems using improved feeding management scheme ➤ Determination of; 1) the time required for a mangrove habitat to remove nutrients (i.e. N, P) from shrimp farm effluents, 2) appropriate pond to mangrove area ratio that will efficiently remove nutrients from shrimp pond effluent, and 3) factors affecting mangrove efficiency to remove nutrients (i.e. surface area mangrove species, bark, leaf litter, etc.).
<p>Objective 2: To promote community-based production and resource enhancement of high-value aquatic resources to secure the livelihood with avoiding rampant, illegal fishing and social conflicts.</p>	<p>Outcome 2: Promotion for the community-based production and resource enhancement of high-value aquatic resources</p>	<p>Output 2: Improvement of organizational, management and entrepreneurial skills of fisherfolks to sustain livelihoods from production, sea ranching and stock enhancement high-value aquatic products.</p> <p>Involvement of the community in the management of the natural resources by disseminating information and participating in the protection and conservation of the coral and sea grass areas which are the natural habitat of seahorses</p>	<p>Activity 2: Promote community-based production and resource enhancement of high-value aquatic resources</p> <ul style="list-style-type: none"> ➤ Sustain the productivity of community-based integrated production abalones and sea cucumbers in the stock enhancement site and surrounding fishing grounds through effective fisheries governance. ➤ Production of juveniles for release from a small-scale solar-powered hatchery operated by fisherfolks. ➤ Promote replication of CBRE in other similar site in the Philippines and other appropriate sites. ➤ Development of technologies on appropriate transport and acclimation strategies of seahorses from the hatchery to the release site; to determine the appropriate size of seahorses for release as well as the appropriate time of release; and to develop appropriate monitoring strategies of the released seahorses; and to establish a community-based seahorse hatchery in the pilot site.
<p>Objective 3: To extend and demonstrate aquaculture technologies to member countries.</p>	<p>Outcome 2: Extending the technologies to rural member countries to hasten economic</p>	<p>Output 3: Extension of technologies to rural member countries to hasten economic development in</p>	<p>Activity 3: Technology and information transfer on resource enhancement practice through training.</p> <ul style="list-style-type: none"> ➤ Extension and demonstration for the breeding, hatchery seed production, nutrition and health management in grouper, seabass, snapper <i>etc.</i> through

	development in the region.	the region.	<p>training program.</p> <p>➤ Special training focusing on the culture of important fisheries commodities such as giant freshwater prawn, cat fish, big head carp.</p>
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3.2 Overall Scope/Description of Project

Activity	Description
<p>Activity 1 Establishment of environment-friendly, responsible aquaculture technology</p>	<p>Sub-activity 1.1 Use of plant-based protein sources in tilapia feeds for improved production traits</p> <p>Use of plant-origin feed ingredients that are available in the region will be explored in the development and/or refinement of aquafeed for cultured freshwater fish species such as tilapia. Activities are geared toward the replacement of fishmeal as the main source of protein in feeds that will further improve production traits of tilapia.</p> <p>Sub-activity 1.2 Responsible aquaculture through aquasilviculture</p> <p>Aquasilviculture as an ecosystem-based pond management strategy will be investigated. Micro-organisms present in the mangrove forest has the ability to transform nutrients to bioavailable form that can be eaten by microorganisms lower in the food web which in turn can serve as food to organisms higher in the food web like the crabs. This process of transformation also improves water quality. The ability of mangroves to improve water quality is affected by the mangrove to pond area ratio (MPR). This study aims to establish the duration for a mangrove habitat to remove nutrients from shrimp pond including other factors that might affect its efficiency</p>
<p>Activity 2 Promotion of community-based production and resource enhancement of high-value aquatic resources</p>	<p>Sub-activity 2.1 Community-based integrated production of abalone <i>Haliotis asinina</i> and sea cucumber <i>Holothuria scabra</i> through culture, sea ranching and stock enhancement</p> <p>Sea cucumber or sandfish are detritus feeders in intertidal flats and reef areas that help aerate marine sediments and recycle nutrients necessary for maintaining marine ecosystems. Donkey ear abalones are gastropods that feed on encrusting algae and micro-particulates in coralline areas. Households in coastal and island communities earn income from selling these high-value export commodities. These species have become overexploited. Community-based integrated production of these species through culture, sea ranching and stock enhancement is proposed for low-income households who live in environments without electricity but with natural food for abalones and sea cucumbers. Thus, seeds will be produced in small-scale solar-powered hatchery. This project aims to maintain the health of the intertidal and reef environment through production systems that use hatchery-bred seeds produced from local broodstocks and grown with natural food while providing sustainable sources of income for coastal dwellers in remote island communities and improve governance of coastal resources in the Philippines and similar areas in Member Countries in Southeast Asia.</p> <p>Sub-activity 2.2 Promotion of resource enhancement of seahorses</p> <p>Seahorses, which are highly exploited for their high price, were</p>

	among the first marine fishes of commercial importance to be listed in the International Union for Conservation of Nature (IUCN) and all seahorses (genus <i>Hippocampus</i>) are listed the Convention on International Trade of Endangered Species of Wild Fauna and Flora (CITES) Appendix II effective May 15, 2004. Seed production technology in seahorses is expected to provide the needed seed for the resource enhancement in the potential release sites. In addition, the baseline assessment of the seahorse natural stocks in the potential release site was conducted in JTF5. The study aims to promote resource enhancement of seahorses by developing appropriate release and monitoring strategies, conduct biological and ecological studies for monitoring of wild and released stocks, and involve the community in the management of the natural resources by establishing a community-based seahorse hatchery.
Activity 3 Technology extension and demonstration	<p>Sub-activity 3.1 Marine fish hatchery training program Aquaculture of high-value marine finfish species continues to develop rapidly in Southeast Asia. This training program will extend and demonstrate the breeding, hatchery seed production, nutrition and health management in grouper, seabass, snapper <i>etc.</i></p> <p>Sub-activity 3.2 Rural aquaculture program Training focusing on promotion of community-based freshwater aquaculture for remote rural areas of Southeast Asia will be organized by SEAFDEC/AQD under this sub-activity, which will promote capacity building for establishing appropriate aquaculture system applicable in remote rural area.</p>

3.3 Activity, Sub-activity and Proposed Budget for 2014-2019 (in case of 5 year project from 2015)

(Unit: USD)

Activity	Sub-Activity	Y2 2015	Y3 2016	Y4 2017	Y5 2018	Y6 2019
Activity 1 Establishment of environment-friendly, responsible aquaculture technology	Sub-activity 1.1: Use of plant-based protein sources in tilapia feeds for improved production traits	11,000	8,800	8,800	18,800	8,800
	Sub-activity 1.2: Responsible aquaculture through aquasilviculture	11,000	8,800	8,800	8,800	8,800
Activity 2 Promotion of community-based production and resource enhancement of high-value aquatic resources	Sub-activity 2.1: Community-based integrated production of abalone <i>Haliotis asinina</i> and sea cucumber <i>Holothuria scabra</i> through culture, sea ranching and stock enhancement	20,000	15,000	15,000	29,000	15,000
	Sub-activity 2.2: Promotion of resource enhancement of seahorses	11,000	8,800	8,800	13,880	8,800

Activity 3 Technology extension and demonstration	Sub-activity 3.1: Marine fish hatchery training program	8,000	7,500	7,500	21,000	7,500
	Sub-activity 3.2: Rural aquaculture program	9,000	8,500	8,500	10,500	8,500
Activity 4 Publication		0	0	0	0	0
Activity 5 Annual progress meeting and international workshop	Sub-activity 5.1: Annual progress meeting	5,000	4,000	4,000	4,000	3,140
	Sub-activity 5.2: International workshop	0	0	0	35,000	0
Activity 6 Coordination by Project Leader		4,000	4,000	4,600	4,000	4,000
	Sub-Total Budget	79,000	65,400	66,000	142,480	64,540

PART II: ACHIEVEMENT OF 2019 PROJECT IMPLEMENTATION

1. Achievements of the Project Implementation for the present year <2019>:

Activity 1.1) Refinement of the previous tilapia feed formulation was done to include other low-cost feed ingredients (*e.g.* poultry by-product meal) in the formulation. Indoor feeding trials of tilapia fingerlings were conducted to test six diet formulations, containing fermented (bacteria- and *Trichoderma*-treated) and non-fermented okara meal, which were compared to a fishmeal-based (FM) diet. The three best performing diets were selected based on improved production traits of tilapia fingerlings such as weight gain and specific growth rate. The performance of these diets is currently being examined in both outdoor tank- and lake-based cages.

Activity 1.2) Compared water quality and shrimp performance of aquasilviculture ponds (separate and mixed) with non-aquasilviculture ponds.

Activity 2.1) The solar-powered hatchery is already operational but abalone spawning and natural food production needs improvement. Monitoring of abalone and sandfish stocks in the release sites continue to show increase. Replication of the CBRE in in Camarines Sur has been initiated.

Activity 2.2) Trials on nursery rearing of seahorses using natural food from the local area and train the fishermen in the community to culture seahorse.

Activity 3) Technology and information transfer on resource enhancement practice through training.

Activity 5) The International workshop on “Promotion of Sustainable Aquaculture, Aquatic Animal Health and Resource Enhancement in Southeast Asia (SARSEA 2019)” was conducted at Iloilo city, 25-27 June, 2019.

2. Information of Present Year Activity including Involved Stakeholders:

List of Actual Sub-activity	Type of activity*	Number of Participants			Spent Budget (USD)
		MCs	SEAFDEC	Others	
Activity 1 Establishment of environment-friendly, responsible aquaculture technology					
Sub-activity 1.1 Use of plant-based protein sources in tilapia feeds for improved production traits	R&D				6,600 (for verification)
Sub-activity 1.2 Responsible aquaculture through aquasilviculture					
Activity 2 Promotion of community-based production and resource enhancement of high-value aquatic resources					
Sub-activity 2.1 Community-based integrated production of abalone <i>Haliotis asinina</i> and sea cucumber <i>Holothuria scabra</i> through culture, sea ranching and stock enhancement	R&D	40 (*)	10 (*)	120 (*)	29,000
Sub-activity 2.2 Promotion of resource enhancement of seahorses	R&D		2 (*)	5 (*)	13,880
Activity 3 Technology extension and demonstration					
Sub-activity 3.1 Marine fish hatchery training program	II: Training	8 (5)			7500 as of July 2019
Sub-activity 3.2 Rural aquaculture program	II: Training to be (conducted 19 Nov.-3 Dec. 2019)	Not applicable at the moment.	Not applicable at the moment.	Not applicable at the moment.	
Activity 4 Publication					
Activity 5 Annual progress meeting and international workshop	Workshop	19 (7)	33 (14)	1 (0)	3,140

Remarks) Regarding the number of participants, please indicate total number of participants (and number of female participants within), such as 20 (10).

**: unconfirmed*

3. Achievements and Expected Outcome/Outputs of the Activity:

Planned activity	Expected outcome/output	Achievements
Activity 1 Establishment of environment-friendly, responsible aquaculture		

technology		
Sub-activity 1.1 Use of plant-based protein sources in tilapia feeds for improved production traits	To produce tilapia with improved production traits using agricultural wastes and by-products as feed ingredients	Information on the effect of agricultural wastes and by-products (ABPs) as alternative ingredients in tilapia feeds on production parameters has been obtained based on the results of indoor tilapia feeding trials. The three best performing diets have been selected and currently being tested in tank- and lake-based cage culture conditions. Economic analysis to determine the viability of using agricultural wastes and by-products in tilapia diets shall be made.
Sub-activity 1.2 Responsible aquaculture through aquasilviculture	To compare culture water quality and shrimp performance of aquasilviculture ponds (mixed and separate) and ponds without mangroves.	Results of the first Run showed higher shrimp survival in both separate (47%) and mixed (39%) aquasilviculture ponds, compared to non-aquasilviculture pond (0%). WSSV load was higher in non-aquasilviculture pond (10^{11} copies/g) compared to aquasilviculture ponds (10^6 copies/g). Water quality was also better in aquasilviculture ponds; lower temperature, salinity and ammonia were observed.
Activity 2 Promotion of community-based production and resource enhancement of high-value aquatic resources		
Sub-activity 2.1 Community-based integrated production of abalone <i>Haliotis asinina</i> and sea cucumber <i>Holothuria scabra</i> through culture, sea ranching and stock enhancement	Aims to increase and sustain high CPUE in release site and spill-over areas; complete and operationalize the solar-powered hatchery for abalone and sandfish; replicate project in other site; and conduct project impact assessment before end of Project.	Since 2015, after the last batch of abalone seeding, monthly monitoring showed CPUE of abalone in the release and spill-over areas continue to increase. CPUE is >150 individuals per hour dive for 3 abalone fishers. Survival, growth and density of sandfish increase, but recovery of sandfish is challenged by social problems. The hatchery structure and reinforcement was completed; hatchery and nursery operations were demonstrated hands-on to local fisherfolks. Two fisherfolks already operate the hatchery and a local electrician oversees the solar-power setup. However, not all hatching runs are successful. Site assessment and social preparations to replicate the project in Camarines Sur province already conducted. Preparation for project impact assessment in Sagay is on-going.
Sub-activity 2.2 Promotion of resource enhancement of seahorses	To determine the appropriate time of release; to determine growth and survival of the released seahorses; and to promote involvement of the community in	Monthly monitoring of seahorse in the pilot site increased over the past years (2015-2019). In 2019, average number of seahorse increased at 33/sampling from 30/sampling in 2015-2018. Backyard hatchery of seahorse on a remote coastal community in Molocaboc Island was developed using solar-powered aerators and utilizing the available natural food collected from the pilot site. New-born and 3-4 months old juvenile seahorses are reared using copepods and mysid shrimps.

	the management of the natural resources; and to establish a community-based hatchery for seahorse.	Nursery rearing of juvenile seahorses in submerged pens until they reach 7 cm stretched height using coral rubbles as substrate for seahorses requires intensive labor in the maintenance of pens. Information education communication (IEC) activities will be continuously conducted to promote resource conservation and protection of seahorses by giving lectures to school children, giving out posters and interviews with the local community. Information education communication (IEC) activity conducted on July 17, 2019 among fisherfolk organization members
Activity 3 Technology extension and demonstration		
Sub-activity 3.1 Marine fish hatchery training program	To train participants to operate a fish hatchery by providing them with technical knowledge and skills on spawning and larval rearing of marine fishes.	The International Training Course on Marine Fish Hatchery was conducted at Tigbauan Main Station from June 24 – July 30, 2019. There were 8 participants. Four (4) participants (1 from Vietnam; 1 from BFAR 3, 1 from Surigao del Sur State University, 1 from Eastern Samar State University) awarded GOJ-TF Training Fellowship Grants. The remaining 4 participants from the Philippines were business owners from the private sector. The participants reared the following species: milkfish, sea bass, tiger grouper, rabbitfish and pompano, with the following survival rates (%): Milkfish (3.75-36); sea bass (40-43.3); tiger grouper (estimated 11.67-15); rabbitfish (estimated 0.83-2); pompano (estimated 0.02-8). The trainees cited the following reasons for the low survival rates: clay, turbid seawater in larval rearing tanks during rainy days, insufficient supply of rotifer for feeding in the afternoon, weak flow or limited supply of seawater, presence of other fish in larval rearing tanks and contamination of natural food. As solutions to the above problems, the trainees made the following recommendations: improve water filtration system, increase number of tanks for natural food culture, provide separate seawater reservoir for larval rearing tanks, provide partition between phytoplankton and zooplankton culture tanks
Sub-activity 3.2 Rural aquaculture program	Enhance participants' knowledge and skills on freshwater aquaculture technologies from broodstock development to	Preparations (e.g. sending out of invitation letters to SEAFDEC member countries, review of training course curriculum and details of schedule, etc.) are in progress. This year's International Training Course on Community-Based Freshwater Aquaculture for Remote Rural Areas in Southeast Asia will be held from November 19 to December 3, 2019 at AQD's Freshwater Station in Binangonan, Rizal.

	seed production, nursery and grow-out phase.	
Activity 4: Publication	To print proceedings for workshop	The proceedings of International workshop on “Promotion of Sustainable Aquaculture, Aquatic Animal Health and Resource Enhancement in Southeast Asia (SARSEA 2019)” to be printed in first quarter of 2020.
Activity 5: Annual progress meeting and international workshop	To hold international workshop	The International workshop on “Promotion of Sustainable Aquaculture, Aquatic Animal Health and Resource Enhancement in Southeast Asia (SARSEA 2019)” was conducted at Iloilo city from 25-27 June, 2019. There were fifty-three participants. Nineteen participants from member countries, one participant from other country and thirty-three participants from SEAFDEC were attended.

4. List of Completed Publications and Others (e.g. technical report, VDO, presentation file, etc.):

List of completed publications for the year 2019	Type of media	Attached e-file
1. Frolan A. Aya , John Carlo L. Unida, Mary Jane P. Sayco, Maria Rowena Romana-Eguia, Nerissa D. Salayo (2019) Converting Agricultural Wastes and By-Products into Valuable Feed Ingredients for Tilapia Culture. Presented at the International workshop on “Promotion of Sustainable Aquaculture, Aquatic Animal Health and Resource Enhancement in Southeast Asia (SARSEA 2019)”, 25-27 Jun 2019, Iloilo Philippines.	Book of Abstract	
2. Eleonor A. Tendencia (2019) Responsible Aquaculture through Aquasilviculture. Presented at the International workshop on “Promotion of Sustainable Aquaculture, Aquatic Animal Health and Resource Enhancement in Southeast Asia (SARSEA 2019)”, 25-27 Jun 2019, Iloilo Philippines.	Book of Abstract	
3. Nerissa D. Salayo , Jon P. Altamirano, Margarita T. Arnaiz, QS Montinola, RT Barrido, RJG Castel, N Pacardo, RN Baylon (2019) Community-based Integrated Production of Abalone, Haliotis asinina, and Sandfish, <i>Holothuria scabra</i> , through Culture, Sea Ranching, and Stock Enhancement. Presented at the International workshop on “Promotion of Sustainable Aquaculture, Aquatic Animal Health and Resource Enhancement in Southeast Asia (SARSEA 2019)”, 25-27 Jun 2019, Iloilo Philippines.	Book of Abstract	
4. Shelah Mae B. Ursua (2019) Promotion of Resource Enhancement of Seahorses. Presented at the International workshop on “Promotion of Sustainable Aquaculture, Aquatic Animal Health and Resource Enhancement in Southeast Asia (SARSEA 2019)”, 25-27 Jun 2019, Iloilo Philippines.	Book of Abstract	

5. Rosenio R. Pagador (2019) Marine Fish Hatchery Training Course. Presented at the International workshop on “Promotion of Sustainable Aquaculture, Aquatic Animal Health and Resource Enhancement in Southeast Asia (SARSEA 2019)”, 25-27 Jun 2019, Iloilo Philippines.	Book of Abstract	

5. Evaluation from Participants of Member Countries for WS and Training Course (if available):

Planned activity	Evaluation/ Views from Participants
Activity 1 Establishment of environment-friendly, responsible aquaculture technology	
Sub-activity 1.1 Use of plant-based protein sources in tilapia feeds for improved production traits	Positive comments from the evaluators during the annual review of GOJ-funded projects. Preliminary results of the study have been disseminated to local and international participants during the training courses organized by AQD.
Sub-activity 1.2 Responsible aquaculture through aquasilviculture	Not applicable
Activity 2 Promotion of community-based production and resource enhancement of high-value aquatic resources	
Sub-activity 2.1 Community-based integrated production of abalone <i>Haliotis asinina</i> and sea cucumber <i>Holothuria scabra</i> through culture, sea ranching and stock enhancement	During field trips, participants in AQD training courses on hatchery and grow-out of abalone and sandfish evaluated this CBRE project in Sagay as successful. Some AQD trainees participate in monthly monitoring to assess performance of stock enhancement of abalone and sandfish. This activity consistently obtained high rating (8-10/10) during GOJ Annual Project Review and Evaluation. The fisherfolks in Sagay learned from demonstration and participation in monitoring released stocks. Fisherfolks capacitated in managing released abalone and sandfish stocks; and obtained economic benefit from regulated harvests (>6cm abalone shell length, >320g sandfish live weight) inside and outside the release sites.
Sub-activity 2.2 Promotion of resource enhancement of seahorses	Progress report presented during SARSEA meeting on June 25-27, 2019. Low-cost seahorse hatchery in a remote community established in Molocaboc Island visited by local communities, BFAR personnel and trainees/students.
Activity 3 Technology extension and demonstration	
Sub-activity 3.1 Marine fish hatchery training program	Participants evaluated the conduct of the training course and gave an overall rating of very good, covering the period 2015- 2019, based on the following criteria: relevance of topics, technical knowledge learned by the participants, their confidence to do duties upon return, and overall coordination of training activities
Sub-activity 3.2 Rural aquaculture program	Not applicable at the moment. Training course on rural aquaculture will be conducted from November 19 to December 3, 2019.
Activity 4: Publication	Not applicable

Activity 5: Annual progress meeting and international workshop	The International workshop on “Promotion of Sustainable Aquaculture, Aquatic Animal Health and Resource Enhancement in Southeast Asia (SARSEA 2019)” was highly evaluate from Participants (average mark was 4.6 out of 5).
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6. Major impacts/issues:

Activity 1.1) Project reached 95% completion; sub-activities on nutritional quality, protein enrichment of ABPs, pesticide residue levels and anti-nutritional factors (ANFs) analyzed to assess suitability of ABPs as alternative feed ingredients for tilapia. Enrichment studies have been conducted to improve the nutritional value as well as possible reduce the ANFs in ABPs. Laboratory trials have been conducted to examine the performance of mixed-sex tilapia fingerlings fed on diets with non-fermented and fermented ABPs. On-farm trials are needed to verify the results of the laboratory trials using sex-reversed tilapia fingerlings. While some equipment has been fabricated to process huge amount of ABPs (e.g. okara meal), plans to develop, in collaboration with government agency or academe, a low-cost equipment such as fermentor to process and treat ABPs into utilizable feed ingredients.

Activity 2.1) The major impact of the CBRE project is the rebuilding of overfished fisheries through releases of hatchery-reared juveniles and the community-based and tri-party collaboration to implement and manage the CBRE. The completed abalone and sandfish hatchery and nursery provided assurance of sustainable CBRE because juveniles for release can be produced locally on small-scale. Fisherfolks have been capacitated in aquaculture operations that will supply seeds for stock enhancement, and also improved their understanding of fish biological processes that enabled them as better stewards of the fisheries and environment. The regulated harvest of abalone (>6cm shell length) and sandfish (320g live weight) from the CBRE site continue to contribute to the income of fishing households and provide funds for their fisherfolks organization. The CBRE can be promoted and replicated in other appropriate sites.

Activity 5) The International workshop on “Promotion of Sustainable Aquaculture, Aquatic Animal Health and Resource Enhancement in Southeast Asia (SARSEA 2019)” was highly evaluate from Participants (average mark was 4.6 out of 5). The participants could be updated on the issues related to sustainable aquaculture, aquatic animal health and resource enhancement, and could put forward recommendations to address the issues.

PART III: ACHIEVEMENTS IN OVERALL PROJECT DURATION

1. Abstract of Achievements in the Overall Project Duration (*project duration 6 years (5years)*):

Activity 1.1) A survey of the major crop industries revealed that high amount of wastes was generated after processing. Analysis of the pesticide residue levels, anti-nutritional factors, and the proximate composition of agricultural wastes and by-products (ABPs) were done to assess the suitability of ABPs as alternative ingredients in tilapia diets. Among the ABPs examined, mango and citrus peels had pesticide residue levels exceeding the limit of quantification of 0.01 mg/kg measured by the Department of Agriculture - Bureau of Plant Industry National Pesticide Analytical Laboratory. Although, these levels were still lower than the maximum residue limits (MRLs) set by the FAO Codex Alimentarius. The limitations to use ABPs in aquaculture feeds were mostly associated with high levels of lignin, saponins, phenols and low to moderate levels of tannins. Proximate composition of selected ABPs had shown their potential as either protein or energy sources in fish feeds. Enrichment studies using ensiling and solid state fermentation of ABPs with *Trichoderma*, *Bacillus subtilis* and yeast were conducted as well to improve the nutritional value of selected ABPs. Information on the effect of mango peel silage (MPS) supplementation on reproductive performance

of Nile tilapia broodstock in tanks and lake-based cage conditions was known, with higher fry production noted for groups supplemented with MPS at 50%. The optimal inclusion levels of soybean curd residues (or okara meal (OM)) and citrus by-products (e.g. citrus peel and citrus pulp) in diets for tilapia fingerlings were determined at 30% and 1%, respectively. The performance of tilapia diets with non-fermented and fermented soybean curd residues examined previously in indoor feeding trials is currently being tested in outdoor tank and lake-based cage conditions. Preliminary study information has been disseminated to participants in training courses organized by AQD, which included BFAR staff.

Activity 1.2) A previous study reported that the presence of mangroves in the receiving environment enhances shrimp survival via an improved incoming water quality. The present study determines the time required for a mangrove habitat to remove nutrients from shrimp farm effluents. Results showed that ammonia, phosphate, chlorophyll *a* and total suspended solids were fluctuating but statistically lower in water drained into mangrove habitat (MPR=2:1 and MPR=4:1) compared to area without mangrove. At MPR=4:1, ammonia is removed from the water after 3 days; TSS after 2 days; phosphate and chlorophyll after 7 days. At MPR=2:1, only ammonia can be efficiently removed and after 3 days. Nutrient removal from the water can be attributed to the nutrient uptake by the mangrove as manifested in the greater increase in growth in terms of stem length of saplings and trees in area receiving shrimp farm effluents compared to those not receiving. Water quality and shrimp performance in aquasilviculture (separate and mixed) and non-aquasilviculture ponds were compared. Results showed higher shrimp survival in both separate (47%) and mixed (39%) aquasilviculture ponds, compared to non-aquasilviculture pond (0%). WSSV load was higher in non-aquasilviculture pond (10^{11} copies/g) compared to aquasilviculture ponds (10^6 copies/g). Water quality was also better in aquasilviculture ponds; lower temperature, salinity and ammonia were observed.

Activity 2.1) The CBRE project has successfully demonstrated that hatchery-reared abalone and sandfish juveniles can rebuild overfished fisheries. The community-based and tri-party collaborative approach between fishers, local government, and research and donor institutions enabled better governance of enhanced fisheries and can provide economic benefits to marginalized fishing communities. Hands-on training in the on-site hatchery capacitated fisherfolks to enable production of seeds for sustaining enhancement activities.

Activity 2.2) To promote resource enhancement of seahorses this study aims to develop appropriate release and monitoring strategies of seahorses with the involvement of community in the management of the natural resources. Transport trials on juvenile seahorses (5-7 cm stretched height) showed optimum stocking density of 3 ind/L for up to 12 h duration. Monthly monitoring of wild seahorses on a patch reef in Molocaboc Island, showed stretch height of seahorses (12-13 cm) and body weight (5.7-8.5 g) were not significantly different from 2015 to 2019. Higher percentage of juveniles was sampled in 2018 and 2019 (5.3%) than in 2015, 2016 and 2017 (1.6, 1.4 and 0.5%, respectively). Gonad development stage showed reproductively mature male and female seahorses were present all year round. Average number of animals (30-34 ind/sampling) in 2016 to 2019 were higher than in 2015 (23 ind/sampling) and 2013 (5 ind/sampling). A low-cost seahorse hatchery facility and fixed-bottom nursery pens are being developed to train the local community on the technique of seahorse seed production using the available natural food in the coral reef areas. Annual information, education and communication (IEC) campaign to the local community includes lectures on seahorse biology and resource management.

Activity 3.1) The main objective of the marine fish hatchery training program is to provide participants

2. Implemented Activities/sub-activities in the Overall Project Duration:

List of Activities	Description of Implemented Activities
Activity 1 Establishment of	

environment-friendly, responsible aquaculture technology	
Sub-activity 1.1 Use of plant-based protein sources in tilapia feeds for improved production traits	<ol style="list-style-type: none"> 1) Review of secondary data of major crop production; conduct interview/ survey of major crop producers and processing plants 2) Analyze chemical composition/ or presence of anti-nutritional factors (ANFs) and pesticide residue levels in agricultural wastes and by-product (ABPs) 3) Testing of processing techniques to improve nutritional value of selected ABPs 4) Conduct of laboratory and outdoor feeding trials to assess the effects of ABPs on performance of tilapia broodstock and fingerlings
Sub-activity 1.2 Responsible aquaculture through aquasilviculture	<ol style="list-style-type: none"> 1) Duration for a mangrove habitat to remove nutrients from shrimp pond including factors affecting mangrove efficiency in nutrient removal of shrimp pond effluents were investigated. 2) The appropriate mangrove to pond area ratio that efficiently remove nutrients from shrimp pond effluents were determined. Culture water quality and shrimp performance of aquasilviculture ponds (mixed and separate) and ponds without mangroves were compared.
Activity 2 Promotion of community-based production and resource enhancement of high-value aquatic resources	
Sub-activity 2.1 Community-based integrated production of abalone <i>Haliotis asinina</i> and sea cucumber <i>Holothuria scabra</i> through culture, sea ranching and stock enhancement	<ol style="list-style-type: none"> 1) Release abalone and sandfish and abalone juveniles; and monthly monitoring of growth, survival and increase in CPUE, including indications of spill-overs to sustain stocks. 2) Construction and operationalization of the solar-powered hatchery; and training of fisherfolks on hatchery operations 3) Site assessment and social preparations to replicate the project in Camarines Sur province already conducted. 4) Preparation for project impact assessment.
Sub-activity 2.2 Promotion of resource enhancement of seahorses	<ol style="list-style-type: none"> 1) To promote resource enhancement of seahorses by developing appropriate release and monitoring strategies, conduct biological and ecological studies for monitoring of wild and released stocks, involve the community in the management of the natural resources and establish a community-based seahorse hatchery and nursery pens.
Activity 3 Technology extension and demonstration	
Sub-activity 3.1 Marine fish hatchery training program	<ol style="list-style-type: none"> 1) Conduct of the marine fish hatchery training program for SEAFDEC member countries, a 37 days training program consisting of lectures and hands-on activities on fish broodstock management, natural food culture, fish health management, fish nutrition, feeds and feeding management, larval rearing of milkfish, sea bass, rabbitfish, groupers, mangrove red snapper and pompano. 2) The course curriculum also includes visits to AQD stations in Dumangas and Guimaras, as well as private farms and hatcheries.
Sub-activity 3.2 Rural aquaculture program	<ol style="list-style-type: none"> 1) Conduct of preparatory activities such as sending out of acceptance letters, revision of training prospectus and details of training activities 2) Coordination of training activities such as lectures, practical

	<p>sessions, farm visits and field trips to various research institutions</p> <p>3) Preparation of training report</p>
Activity 4 Publication	The proceedings of International workshop on “Promotion of Sustainable Aquaculture, Aquatic Animal Health and Resource Enhancement in Southeast Asia (SARSEA 2019)” to be printed in first quarter of 2020.
Activity 5 Annual progress meeting and international workshop	Annual and semi-annual progress meeting were conducted every year. The International workshop on “Promotion of Sustainable Aquaculture, Aquatic Animal Health and Resource Enhancement in Southeast Asia (SARSEA 2019)” was conducted at Iloilo city from 25-27 June, 2019.

3. Achievements and Outcomes/Outputs of Activities in the Overall Project Duration:

List of Activities	Achievements and Outcomes/Outputs of Activities
Activity 1 Establishment of environment-friendly, responsible aquaculture technology	
Sub-activity 1.1 Use of plant-based protein sources in tilapia feeds for improved production traits	<ol style="list-style-type: none"> 1) Survey of major crop industries revealed high amount of agricultural wastes and by-products (ABPs) generated after processing. No use in aquaculture was reported as well as treatments done prior to disposal of these ABPs. 2) Among the ABPs examined, mango and citrus peels had pesticide residue levels exceeding the limit of quantification of 0.01 mg/kg measured by the Department of Agriculture - Bureau of Plant Industry National Pesticide Analytical Laboratory. However, these levels were still lower than the maximum residue limits (MRLs) set by the FAO Codex Alimentarius. ABPs contained high levels of lignin, saponins, phenols and low to moderate levels of tannins. Based on the proximate composition, ABPs can either be a protein or energy source in fish feeds. 3) Enrichment studies of ABPs by ensiling or with <i>Trichoderma harzianum</i> Rifai by solid state fermentation have been shown to improve their protein contents with nutrient supplementation. Fermentation of ABPs particularly soybean curd residues with <i>Bacillus subtilis</i> and yeast was also done in the laboratory. 4) Feeding trials showed that dietary substitution of fishmeal with mango peel silage did not show any adverse effects on fry production of Nile tilapia broodstock. Tilapia fingerlings grew well in diets with 30% soybean cured residues as well as when fed diets supplemented with 1% each of citrus pulp and citrus peel.
Sub-activity 1.2 Responsible aquaculture through aquasilviculture	<ol style="list-style-type: none"> 1) Results showed that ammonia, phosphate, chlorophyll a and total suspended solids were fluctuating but statistically lower in water drained into mangrove habitat (MPR=2:1 and MPR=4:1) compared to area without mangrove. At MPR=4:1, ammonia is removed from the water after 3 days; TSS after 2 days; phosphate and chlorophyll after 7 days. At MPR=2:1, only ammonia can be efficiently removed and after 3 days. 2) The growth of plants in areas receiving and not receiving shrimp farm effluents were compared by measuring the monthly increase in height of the seedlings and the increase in length in the stem between two nodes in saplings and trees. After 3 months, increase in growth was greater in plants in area receiving shrimp farm

	<p>effluents compared to those not receiving, except for the seedlings. This indicate that mangroves purify the water by nutrient uptake as supported by the data showing greater increase in stem length in saplings and trees.</p> <p>3) Results of the first run showed higher shrimp survival in both separate (47%) and mixed (39%) aquasilviculture ponds, compared to non-aquasilviculture pond (0%). WSSV load was higher in non-aquasilviculture pond (1011 copies/g) compared to aquasilviculture ponds (106 copies/g). Water quality was also better in aquasilviculture ponds; lower temperature, salinity and ammonia were observed.</p>
Activity 2 Promotion of community-based production and resource enhancement of high-value aquatic resources	
Sub-activity 2.1 Community-based integrated production of abalone <i>Haliotis asinina</i> and sea cucumber <i>Holothuria scabra</i> through culture, sea ranching and stock enhancement	<p>1) The solar-powered hatchery structure was completed; hatchery and nursery operations were demonstrated hands-on to local fisherfolks. Two fisherfolks already operate the hatchery and a local electrician oversees the solar-power setup.</p> <p>2) Monthly monitoring showed CPUE of abalone and sandfish in the release and spill-over areas continue to increase. The corals where abalone lives grew due to protection by local fisherfolks.</p> <p>3) Site assessment and social preparations to replicate the project in Camarines Sur province already conducted. Preparation for project impact assessment in is on-going.</p>
Sub-activity 2.2 Promotion of resource enhancement of seahorses	<p>1) Transport trials on three size groups of juvenile seahorses (5, 6, and 7 cm stretched height) showed optimum stocking density of 3 ind/L for all size groups up to 12 h transport duration.</p> <p>2) Monthly monitoring of seahorses on a patch reef in Molocaboc Island, showed average stretch height of seahorses (11.9 - 12.7 cm) and body weight (5.74-8.5 g) was not significantly different from 2015 to 2019.</p> <p>3) Higher percentage of juveniles were sampled in 2018 and 2019 (5.3%) than in 2015, 2016 and 2017 (1.6, 1.4 and 0.5%, respectively), which accounted for the decrease of the average body weight.</p> <p>4) Gonad development stage showed reproductively mature male and female seahorses were present all year round.</p> <p>5) Average number of animals (30-34 ind/sampling) in 2016 to 2019 was higher than in 2015 (23 ± 4 ind/sampling).</p> <p>6) A low-cost seahorse hatchery facility and fixed-bottom nursery pens are being developed to train the local community on the technique of seahorse seed production using the available natural food in the coral reef areas.</p> <p>7) Annual information, education and communication (IEC) campaign to the local community includes lectures on seahorse biology and resource management.</p>
Activity 3 Technology extension and demonstration	
Sub-activity 3.1 Marine fish hatchery training	<p>1) Implemented the Marine fish hatchery training course as scheduled; participants from member countries successfully cultured</p>

program	phytoplankton (green algae) and zooplankton (rotifer); successfully reared marine fishes (milkfish, groupers, sea bass, mangrove red snappers, rabbitfish and pompano) from day 0 until termination of larval rearing runs or the duration of the training course; and lastly, GOJ-funded participants submitted narrative reports.
Sub-activity 3.2 Rural aquaculture program	<ol style="list-style-type: none"> 1) Preparatory activities were successfully done for the yearly conduct of the rural aquaculture training program 2) Training activities were done as scheduled, with the conduct of rapid rural appraisal activities in small-scale fish farming communities closely coordinated with the Municipal Agricultural Offices; a total of 25 participants completed the rural aquaculture program from 2015-2018 3) Training report submitted summarizing the activities conducted, recommendations, project proposals, and assessment on the overall conduct of the training program
Activity 4 Publication	
Activity 5 Annual progress meeting and international workshop	Annual and semi-annual progress meeting were conducted every year, it contributed for proper practice of the project. The International workshop on “Promotion of Sustainable Aquaculture, Aquatic Animal Health and Resource Enhancement in Southeast Asia (SARSEA 2019)” was conducted at Iloilo city from 25-27 June, 2019. There were fifty-three participants. Nineteen participants from member countries, one participant from other country and thirty-three participants from SEAFDEC were attended. The participants also reported on the status of sustainable aquaculture, resource enhancement and aquatic animal health of their respective countries. The participants could be updated on the issues related to sustainable aquaculture, aquatic animal health and resource enhancement, and could put forward recommendations to address the issues.

4. Evaluation and Major Impacts/Issues in the Overall Project Duration:

Activity 1.1) Project reached 95% completion; sub-activities on nutritional quality, protein enrichment of ABPs, pesticide residue levels and anti-nutritional factors (ANFs) analyzed to assess suitability of ABPs as alternative feed ingredients for tilapia. Enrichment studies have been conducted to improve the nutritional value as well as possible reduce the ANFs in ABPs. Laboratory trials have been conducted to examine the performance of mixed-sex tilapia fingerlings fed on diets with non-fermented and fermented ABPs. On-farm trials are needed to verify the results of the laboratory trials using sex-reversed tilapia fingerlings. While some equipment has been fabricated to process huge amount of ABPs (e.g. okara meal), plans to develop, in collaboration with government agency or academe, a low-cost equipment such as fermentor to process and treat ABPs into utilizable feed ingredients.

Activity 2.1) The major impact of the CBRE project is the rebuilding of overfished fisheries through releases of hatchery-reared juveniles and the community-based and tri-party collaboration to implement and manage the CBRE. The completed abalone and sandfish hatchery and nursery provided assurance of sustainable CBRE because juveniles for release can be produced locally on small-scale. Fisherfolks have been capacitated in aquaculture operations that will supply seeds for stock enhancement, and also improved their understanding of fish biological processes that enabled them as better stewards of the fisheries and environment. The regulated harvest of abalone (>6cm shell length) and sandfish (320g live weight) from the CBRE site continue to contribute to the income of fishing households and provide funds for their fisherfolks organization. The CBRE can be promoted and replicated in other appropriate sites.

Activity 3.2) The rural aquaculture training program was successful in view of the recommendations from the participants to further continue the conduct of this training program. The Rapid Rural Activities (RRA) provided the participants with a learning opportunity to interact with various stakeholders in a community. Engaging the community will definitely enhance their social role as extension workers in disseminating the aquaculture technologies as well as educating the stakeholders on good aquaculture practices. Participants were pleased with the overall coordination and quality of the training.

Activity 5) The International workshop on “Promotion of Sustainable Aquaculture, Aquatic Animal Health and Resource Enhancement in Southeast Asia (SARSEA 2019)” was highly evaluate from Participants (average mark was 4.6 out of 5). The participants could be updated on the issues related to sustainable aquaculture, aquatic animal health and resource enhancement, and could put forward recommendations to address the issues.

5. Publications and Others (e.g. technical report, VDO, presentation file, etc.):

Maria Rowena R. Romana-Eguia, Fe D. Parado-Estepa, Nerissa D. Salayo and Ma, Junemie Hazel Lebata-Ramos edit. (2015) Resource Enhancement and Sustainable Aquaculture Practices in Southeast Asia (RESA2014). Proceedings of the international Workshop, ISBN: 978-971-9931-04-1, SEAFDEC AQD

Salayo ND, Castel RJG, Barrido RT, Tormon DHM, Azuma T. (2016) Community-based stock enhancement of abalone, *Haliotis asinina* in Sagay marine reserve: Achievements, limitations and directions. *In*: Hajime K, Iwata T, Theparoonrat Y, Manajit N, Sulit VT (eds.). Consolidating the Strategies for Fishery Resources Enhancement in Southeast Asia. Proceedings of the Symposium on Strategy for Fisheries Resources Enhancement in the Southeast Asian Region, Pattaya, Thailand; 27-30 July 2015; Samutprakan, Thailand: Training Department, Southeast Asian Fisheries Development Center; pp. 131-135.

SEAFDEC AQD (2017) “AQUACULTURE: KEY TO REBUILDING COASTAL RESOURCES AND LIVELIHOOD THROUGH” Community-Based Resource Enhancement (CBRE) in Sagay Marine Reserve, Sagay City, Philippine (Flyers/Brochures), SEAFDEC AQD.

SEAFDEC AQD (2017) “ABALONE Culture” (Flyers/Brochures), SEAFDEC AQD.

S.M.B. Ursua (2017). Initiating resource enhancement of seahorses: a case study of Sagay Marine reserve in Central Philippines. *Fish for the People*, Vol. 15 Number 3. pages 56-59.

Aya FA (2017) Utilizing alternative ingredients in aquafeeds for sustainable aquaculture. *Fish for the People* Vol. 15 No. 3, 37-44 (some of project activities were discussed in this paper)

Tendencia EA, VJ Estilo (2018) Ecological Approaches Toward Sustainable Aquaculture. Presented at the 4th International Conference on Tropical and Coastal Ecosystem and Development (4th ICTCRED), 30-31 Oct 2018, Semarang Indonesia

Nerissa D. Salayo(2018) Updates on SEAFDEC/AQD Resource Enhancement Activities, Regional Technical Meeting on Resource Enhancement in SEA, Bangkok Thailand, 24-26 April 2018.

Frolan A. Aya, John Carlo L. Unida, Mary Jane P. Sayco, Maria Rowena Romana-Eguia, Nerissa D. Salayo (2019) Converting Agricultural Wastes and By-Products into Valuable Feed Ingredients for Tilapia Culture. Presented at the International workshop on “Promotion of Sustainable Aquaculture, Aquatic Animal Health and Resource Enhancement in Southeast Asia (SARSEA 2019)”, 25-27 Jun 2019, Iloilo Philippines.

Eleonor A. Tendencia (2019) Responsible Aquaculture through Aquasilviculture. Presented at the International workshop on “Promotion of Sustainable Aquaculture, Aquatic Animal Health and Resource Enhancement in Southeast Asia (SARSEA 2019)”, 25-27 Jun 2019, Iloilo Philippines.

Nerissa D. Salayo, Jon P. Altamirano, Margarita T. Arnaiz, QS Montinola, RT Barrido, RJG Castel, N Pacardo, RN Baylon (2019) Community-based Integrated Production of Abalone, *Haliotis asinina*, and Sandfish, *Holothuria scabra*, through Culture, Sea Ranching, and Stock Enhancement. Presented at the International workshop on “Promotion of Sustainable Aquaculture, Aquatic Animal Health and Resource Enhancement in Southeast Asia (SARSEA 2019)”, 25-27 Jun 2019, Iloilo Philippines.

Shelah Mae B. Ursua (2019) Promotion of Resource Enhancement of Seahorses. Presented at the International workshop on “Promotion of Sustainable Aquaculture, Aquatic Animal Health and Resource Enhancement in Southeast Asia (SARSEA 2019)”, 25-27 Jun 2019, Iloilo Philippines.

Rosenio R. Pagador (2019) Marine Fish Hatchery Training Course. Presented at the International workshop on “Promotion of Sustainable Aquaculture, Aquatic Animal Health and Resource Enhancement in Southeast Asia (SARSEA 2019)”, 25-27 Jun 2019, Iloilo Philippines.
