

Meeting Social and Economic Challenges in Southeast Asian Aquaculture: Targeting Rural Aquaculture Development for Poverty Alleviation

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In 2010, five Southeast Asian countries led by Vietnam and followed by Indonesia, Thailand, Myanmar, and the Philippines, have successfully joined the ranks of the world's top 10 producers of food fish from aquaculture. Taking into account aquaculture production in general which includes seaweeds, the region's production from aquaculture had contributed more than 45% to the region's total fishery production, about 24% to the world's production from aquaculture, and about 10% to the world's total fishery production in 2010. As shown in the statistics reports, most of the aforementioned countries recorded double-digit growth rates in aquaculture production from 2006 to 2010, ranging from 18 to 62 percent. Another milestone in the fisheries sector of the region is the engagement of about 11 million people in aquaculture and its ancillary industries. In spite of these figures, the region's rural areas where aquaculture development is taking giant strides remain the most impoverished groups in most countries of Southeast Asia. In an attempt to address this concern, SEAFDEC Aquaculture Department compiled the results of the implementation of its program on Meeting Social and Economic Challenges in Aquaculture which had been tried in local setting in the Philippines, with the objective of developing aquaculture technology adoption pathways that could be promoted in the other Southeast Asian countries with the same conditions as those in study sites in the Philippines, as means of alleviating poverty in rural areas.

The Southeast Asian region has been significantly contributing substantial volumes of fish from aquaculture to the world's total supply of fish. Of the world aquaculture production of about 60 million metric tons in 2010, about 24% was contributed by the Southeast Asian countries where aquaculture production during the past decade increased by more than three times from 4.2 million mt in 2001 to 14.2 million mt in 2010. Therefore, through aquaculture, the Southeast Asian region has the capacity of improving the availability and adequacy of supply of food fish not only for domestic consumption of its people but also for export. In 2010, five Southeast Asian countries were among the world's 10 highest producers of fish from aquaculture (Table 1). If production of aquatic plants is included in the 2010 total aquaculture production of the region, Indonesia would rank first among the countries followed by Vietnam, Philippines, Thailand, and Myanmar

Table 1. World's top ten producers of food fish from aquaculture

Production (mt)	World Rank	Country
36,734,215	1 st	China
4,648,851	2 nd	India
2,671,800	3rd	Vietnam
2,304,828	4th	Indonesia
1,308,515	5 th	Bangladesh
1,286,122	6th	Thailand
1,008,010	7 th	Norway
919,585	8 th	Egypt
850,697	9th	Myanmar
744,695	10th	Philippines
7,395,281	-	Others

Source: The State of World Fisheries and Aquaculture 2012, FAO, Rome, Italy

(Table 2). Following the current trend in terms of development and output, the region's aquaculture production volume which increased by more than 70% in 2001-2010, is expected to continue to increase in the next decades.

Based on such statistics, aquaculture could be seen as a sector that could enhance the economic development of the countries in the region while fulfilling the necessary protein requirement of the people especially those in rural areas. Meanwhile, trade of fish and fishery products with developed economies requiring high supply of food fish such as Japan, USA and the European Union, as well as intra-regional trade with countries such as Singapore, has been on the rise. As a result, the fisheries sector and its ancillary industries of Southeast Asia continue to benefit from the growth of export trade of fish, crabs, shrimps, shellfishes, and seaweeds, produced through aquaculture. However, it should be noted that the level of development of aquaculture and the distribution of benefits have varied widely across the countries of Southeast Asia.

Harvests from the region's fish farms of about 14.2 million mt in 2010 continue to feed significant number of people in Southeast Asia and its trading partners beyond the region. With about 52% coming from mariculture, 27% from freshwater culture and 21% from brackishwater culture (SEAFDEC, 2012a) the total production contributes significant volume of fish that fulfills the rice-fish diet of

Table 2. Total aquaculture production of the Southeast Asian countries (mt), 2006-2010

Countries	2006	2007	2008	2009	2010
Brunei Darussalam	700	674	390	460	421
Cambodia	41,400	50,200	39,720	50,000	60,000
Indonesia	2,377,474	2,466,030	3,855,200	4,780,100	6,277,923
Lao PDR	78,000	63,250	64,300	75,000	82,100
Malaysia	212,028	268,514	240,133	333,445	373,151
Myanmar	574,990	604,657	653,855	724,163	850,959
Philippines	2,092,275	2,214,826	2,407,698	2,477,392	2,545,765
Singapore	8,572	4,504	3,518	3,566	3,501
Thailand	1,353,021	1,370,431	1,330,800	1,396,010	1,286,117
Vietnam	1,687,717	2,194,500	2,468,320	2,539,300	2,706,800
TOTAL	8,426,187	9,237,586	11,063,934	12,379,436	14,186,737

Source: *Fishery Statistical Bulletin of Southeast Asia 2010*, Southeast Asian Fisheries Development Center, Bangkok, Thailand

most low and middle income-earning households both in rural and urban areas of the region.

The supply of freshwater species from aquaculture, such as tilapias, carps, catfishes, gouramis, and shrimps and prawns among others, has made fish affordable for many households throughout the region, especially in communities near the Mekong River Basin. In effect, the average fish consumption of Southeast Asia remained to be higher than 27.0 kg/person/year than the global average of 17.0 kg/person/year in 2009. In the case of archipelagic Philippines and Indonesia, production of milkfish in marine cages, ponds and pens have significantly augmented the demand gap for marine fish species due to declining catch from capture fisheries. Fish consumption in the Philippines at 28.0 kg/person/year is way above global average, and 4.0 kg of this comprised milkfish and 1.0 kg is tilapia, both species produced from aquaculture (BFAR, 2010).

The aquaculture growth in Southeast Asia is mainly driven by the scientific and technological breakthroughs developed in the region, as well as the level of adoption of the culture technologies among receptive and aggressive entrepreneurs. Countries with capital-rich entrepreneurs such as Thailand, Indonesia and Malaysia tend to profit more from aquaculture. Furthermore, institutional investment on aquaculture development has mainly centered on “research” and “development”.

Hence, the importance of sustainable and responsible aquaculture has not been adequately disseminated and understood in most rural communities. Meanwhile, in spite of increases in the region’s aquaculture production, the challenge to produce more fish does not cease as the region continues to deal with rapid increases in population and the need for food and livelihood by its people.

Nevertheless, statistics have shown that the average aquaculture production per fish farmer in Asia at 2.4 mt per year, is second lowest compared with Africa’s 2.0 mt per year (FAO, 2010).

Notwithstanding the problems and enormous needs, the present and future role of aquaculture in the region offer optimism as the region’s populace is projected to remain fish-eating. Therefore, the regional fish production of 31.5 million mt in 2010 (45% of which came from aquaculture) must have provided food fish to fulfill the region’s estimated consumption of about 16.7 million mt of fish, while also providing over 10.0 million mt to fish-deficit markets, without ignoring the amount of fish about 20% of the region’s fish production, which is converted into fish meal and fish oil (FAO, 2012). Nonetheless, such development implies that the region’s fish production including those from aquaculture could easily provide economic gains for the Southeast Asian countries.



Bountiful milkfish harvest from marine cages operated by fisherfolks in Guimaras Island, under the guidance of SEAFDEC/AQD

Rural Aquaculture Development in Southeast Asia

Considering the aforementioned scenario, it has become necessary for the region to ensure the successful adoption of aquaculture technologies and realignment of R&D direction and policies that would pave the way to improve livelihood and alleviate poverty in rural communities. Therefore, while acknowledging the global accounts of remarkable milestones of aquaculture in Southeast Asia, the *ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security Towards 2020: Fish for the People 2020 “Adaptation to a Changing Environment”* in June 2011 in Bangkok, Thailand, was of the general view that the development of aquaculture in the region should address the shortcomings and challenges especially in the development of the rural areas (SEAFDEC, 2011a; SEAFDEC, 2011b). In the midst of such realities and in order to ensure the sustainable development of aquaculture in the region, the Resolution adopted during the June 2011 ASEAN-SEAFDEC Conference implored the need (Item15) “to enhance the awareness that aquaculture makes to food security and sustainable livelihoods to deliver a responsible increase in aquaculture production that promotes aquaculture for rural development as means of rational use of land and water resources”. The accompanying Plan of Action (Item 14) specifically emphasized the need to “raise awareness of the need to develop financial incentives, especially for small-scale stakeholders and cooperatives, e.g. micro-credit, with national and regional institutional assistance for the responsible development of fisheries enterprises and developmental activities that will optimize socio-economic returns and food security”.

In this connection, the SEAFDEC Aquaculture Department (AQD) developed an R&D program, the so-called “Meeting Social and Economic Challenges in Aquaculture Program” or MSECAP to address the major issues and concerns in aquaculture that were identified during the ASEAN-SEAFDEC Conference. Therefore, relevant provisions stipulated in the 2011 Resolution and Plan of Action had been used as framework for the operationalization of MSECAP, the scope of which is shown in (Box 1).

Furthermore, in order to address the inadequacy of human resource to mediate the transfer of knowledge and practices of sustainable aquaculture technologies from researchers and fisher farmers, a holistic approach that includes the conduct of various training formats has been incorporated in the MSECAP. This is aimed at enhancing the extension and adoption of sustainable aquaculture technologies, especially in the remote rural fishing communities. In

Box 1. Scope of AQD’s Program on Meeting Social and Economic Challenges in Aquaculture (MSECAP)

- (i) Enhancing the role of aquaculture in addressing food, income and livelihood security through improved governance, multi-agency collaboration, and comprehensive and inter-disciplinary approaches;
- (ii) Promoting sustainable aquaculture through enabling policies that support the management of natural and environmental resources;
- (iii) Enabling mechanisms, institutions and infrastructure to encourage adoption of better aquaculture practices;
- (iv) Understanding and improving linkages from production to marketing and trade of fishery products to support small and medium enterprise (SME) development; and
- (v) Strengthening the capacity of aquaculture stakeholders by mainstreaming specific rural and peri-urban aquaculture programs and policies in local, national and international development programs.

addition, developing policies that will provide basis for the promulgation of practical aquaculture ordinances to be espoused by local government units is also being promoted as part of the MSECAP. Such ordinances are meant to guide and ensure the implementation of responsible aquaculture practices in the region.

SEAFDEC Initiatives to Address Social and Economic Challenges in Aquaculture

In an attempt to address the social and economic issues in aquaculture in Southeast Asia as called for in the 2011 Resolution and Plan of Action, AQD realigned its research and development (R&D) programs as a fundamental step towards unraveling the impinging aquaculture problems in the region. In particular, MSECAP (Box 2) is being promoted as means to develop and implement social and economic strategies in aquaculture and resource management to secure food and incomes of the region’s populace as well as alleviate poverty in rural communities through enhanced stakeholder-collaboration.

Box 2. Main objectives of MSECAP

MSECAP is aimed at:

- a) prioritizing collaborative R&D in aquaculture in the region to have a clear regional assessment and understanding of the role of aquaculture in poverty alleviation and provide basis for policy formulation;
- b) allocating R&D resources to address emerging issues on the impacts of climate change and global trade on aquaculture with emphasis on small-holder fish farmers; and
- c) enhancing multi-agency collaboration between and among SEAFDEC and its Member Countries, and other regional organizations to enhance sharing of information and resources towards alleviating the socioeconomic conditions of the poor sector of region.



Social and biological science researchers team-up in advancing technology dissemination and adoption by fisherfolk project co-operators



Grow-out cages for tilapia installed along irrigation ways in Dumarao to maximize water uses

Under the MSECAP, specific five-year targets (2012-2016) had been set (**Box 3**) through the implementation of R&D activities that explore the participatory and community-based modality in the promotion of aquaculture technologies in socially and economically disadvantaged rural communities. Initially conducted in the Philippines, socio-economic studies combined with on-farm site technology dissemination and demonstration activities are expected to deliver results that will converge towards developing prototype aquaculture technology adoption pathways suitable to the current social and economic development needs of the region, in accordance with the recommendations of the 2011 ASEAN-SEAFDEC Conference.

Specifically, the technology adoption models for inland and coastal aquaculture systems are foremost expected to secure food supply and livelihoods for households in

Box 3. Five-year targets of the Meeting Social and Economic Challenges in Aquaculture Program (MSECAP)

- Promotion of collaborative means of disseminating and adopting aquaculture technologies to secure food for inland and coastal communities, by:
 - co-establishing with stakeholders the necessary baseline information for designing demonstration activities that promote culture of new and indigenous aquaculture species in upland and inland communities; and
 - formulating appropriate adoption pathways for aquaculture technologies for the development of technology demonstration, implementation and adoption studies/activities.
- Assistance in the development of aquaculture-based small and medium enterprises (SMEs), by:
 - determining through season-long training, on-farm economic indicators for identifying viable technologies suitable for SMEs owned and operated by small-holder fish farmers; and
 - training fishers and other stakeholders on entrepreneurial skills and financial management of aquaculture enterprises.
- Enhancing the mechanisms for good governance and involvement of stakeholders in managing aquatic resources, through:
 - recommendations for the development of policies and up-scaled ordinances to support and maintain fisheries management mechanisms resulting from on-field studies; and
 - promotion of increased adoption of full-cycle aquaculture technologies among fish farmers to reduce and stop negative environmental impacts of unsustainable culture practices.
- Assistance to collaborators in the establishment of sustainable fish farm models that showcase commercially viable business using aquaculture technologies; through
 - recommendations for development of policies and up-scaled ordinances to support and maintain fisheries management mechanisms resulting from on-field studies; and
 - promotion of increased adoption of full-cycle aquaculture technologies among fish farmers to reduce and stop negative environmental impacts of unsustainable culture practices.
- Organization of a network of social science experts in aquaculture from all SEAFDEC Member Countries and partners, by:
 - enhancing the initiatives and collaboration forged by the ASEAN-SEAFDEC Human Resources Development Training in Rural Aquaculture in 2009 for launching further aquaculture capacity development training, and dissemination of aquaculture and resource enhancement protocols in the Region; and
 - conducting a regional workshop to enhance collaboration and address social science R&D and technology adoption action plans in inland and coastal communities, especially on matters for securing food and income through aquaculture in the region.



Tilapia cage culture along irrigation ways to secure fish supply in rural communities

Box 4. Strategies to promote MSECAP in the Southeast Asian region

On prioritizing collaborative R&D in aquaculture in the region. Through MSECAP, the foundation for conducting major activities to correspond to the three-pronged recommendations which are regional in scope had been established. Results of the partnership with various stakeholders at all levels constitute the technology adoption models that are verified and developed in various Philippine settings, which could be disseminated to the other Southeast Asian countries having similar environments as well as food and livelihood constraints. A regional network is therefore proposed, possibly anchored on the already established ASEAN-SEAFDEC Human Resources Development Program in Aquaculture, in the forthcoming years to disseminate R&D results that target the inclusive participation of marginalized stakeholders in social and economic development activities in aquaculture.

On allocating R&D resources to address emerging issues. MSECAP initiated a study on the verification, demonstration and adoption of cage culture of the giant freshwater prawn (*Macrobrachium rosenbergii*) among small-holder fish farmers in Laguna Lake near Metro Manila, Philippines. MSECAP is also engaged in other projects that demonstrate community-based activities to catalyze the promotion and adoption of hatchery and grow-out culture of freshwater species such as tilapia and catfishes in inland farming communities in Capiz Province in central Philippines, which had been confronted by changing rural landscapes due to construction of irrigation systems and facilities.

On enhancing multi-agency collaboration. The 2011 ASEAN-SEAFDEC Conference likewise recommended the need to implement collaborative ways for disseminating and adopting aquaculture technologies to secure food for inland and coastal communities; and sharing of information and resources between and among SEAFDEC and its Member Countries and other organizations in addressing the common problems of alleviating the socio-economic conditions of the poor sector of the region. To fulfill this recommendation, SEAFDEC/AQD has co-established with stakeholders the necessary baseline information for designing demonstration activities that promote the culture of new and indigenous aquaculture species in various rural settings.

diverse communities such as the remote rural, peri-urban and urban areas in Southeast Asia. Furthermore, these adoption pathways are envisioned to serve as guide in the promotion of aquaculture initiatives in other Southeast Asian countries with aquaculture potentials but with similar social and economic limitations as those in the Philippine settings. The strategies for the implementation of MSECAP with respect to the recommendations during the ASEAN-SEAFDEC Conference in 2011 are shown in **Box 4**.

Moreover, MSECAP is also envisioned to develop appropriate adoption pathways for aquaculture technologies that will guide technology demonstration, implementation and adoption in communities that were left behind in previous phases of aquaculture development. This adoption pathways will also document resource use changes over time as well as the socio-economic conditions in study sites with the adoption of aquaculture technology; examine the factors that contribute or impede the acceptability and



Tilapia cage culture in freshwater impoundments in Dumarao, Capiz could secure fish food for inland small-holder farmers



Fish cages in Laguna Lake near Metro Manila, Philippines for food security of fishers (Photo: D. Israel)

adoption of technologies; and determine whether there are differences in knowledge of and attitudes towards aquaculture technology adoption among community members and stakeholders, and between marine and freshwater culture environments.

Thus, prototype adoption pathways for inland freshwater aquaculture technologies is a work in progress under the MSECAP. The first case is in Dumarao, a farming municipality in the Province of Capiz in Western Visayas, Philippines (**Box 5**) for tilapia culture, and the other in fishing communities surrounding Laguna Lake in Luzon, Philippines (**Box 6**) for freshwater prawn grow-out culture, where the demonstration set-up attained a very high survival rate of 79%.

Box 5. Tilapia and catfish culture in flooded rice paddies in Dumarao, Capiz (central Philippines)

Development of the **technology adoption pathway for freshwater aquaculture** was based on the lessons learned from the implementation of the study on *Socio-economic Impact of Adoption of Sustainable Aquaculture Technologies in Selected Fisherfolk Communities* conducted by AQD in the municipality of Dumarao, Capiz Province in central Philippines. In this upland rural municipality, about 23.7 ha of agricultural lands in four villages had been submerged the whole year in 2006, while construction of an unfinished dam rendered many rice farm areas unsuitable for agriculture. With assistance of the local government of Dumarao, a cooperative of community members was organized to serve as recipient of aquaculture interventions. Thus, SEAFDEC/AQD introduced the tilapia grow-out technology in flooded rice farms through on-farm demonstrations of hatchery and grow-out operations in 2007. Although the technology spread to other villages, households with capital were the first to set up tilapia cage culture in submerged farmlands. However, investments were not sustained as operations were relegated to hired workers, but local residents with more entrepreneurial skills learned hatchery operations that contributed to improving the availability of tilapia juveniles. The result led to increased number of tilapia grow-out operators, but the cooperative did not prosper since the modality for introducing and maintaining grow-out culture as livelihoods was meant for farmers whose rice paddies had been affected by flooding. Meanwhile, some members of the cooperative who ventured on their own succeeded in sustaining their livelihoods, by operating their own farms, adapting the processes of culturing tilapia in backyard ponds using overflowing surface water, and practicing alternate feeding. On the average, tilapia growers in Dumarao mostly own one cage with size ranging from 4x2.5 to 4x10.0 meters, while only one grower has more than five cages. The growers reported obtaining positive income attributed to having pre-agreed selling price and harvest arrangements to minimize competition. Later in 2011, SEAFDEC/AQD also conducted on-site demonstration of induced spawning of catfish. Although unsuccessful during the initial attempts, some farmers expressed interest to pursue catfish culture when funds become available and weather conditions permit. The stakeholders generally acknowledged that the introduction of aquaculture technologies has improved the availability of fish for local consumption in an upland farming community, aside from creating new livelihoods for displaced rice farmers due to the changing landscape arising from infrastructure development.

Box 6. Collaborative cage culture of giant freshwater prawn with fish farmers in Laguna Lake

The prawn culture study in Laguna Lake near Metro Manila was conceived to respond to the need for actively promoting aquaculture technologies that offer livelihood opportunities to small-holder cage culture operators in peri-urban communities along Laguna Lake. Specifically, the study on cage culture of giant freshwater prawn (GFP) aims to: (i) conduct specific training programs to respond to the pressing need for extending the technologies to the Southeast Asian countries to improve livelihoods and economic development in the region; and (ii) ensure sustainable food supply particularly in remote rural areas of Southeast Asia. The hapa net cages set up in the lake-based facilities of AQD's Binangonan Freshwater Station (BFS) were stocked with GFP post larvae and fed commercial diet. The mean weight range per cage after five months culture was between 6.0 and 7.5 kg while the mean survival rate ranged from 46 to 56%. A group of fish farmers through their local government leaders were invited to take part during the sampling of the stocks. An ex-ante economic analysis of this culture system showed that Php 16,300 net income per module can be expected after 6 months culture period. Similar with other MSECAP activities, this initiative featured a multi-stakeholder collaboration to facilitate project implementation and optimize resource use. Small-scale tilapia fish farm operators signed in as direct project collaborators with the intention of obtaining additional incomes from GFP culture, where the fish farmers offered to modify their existing tilapia cages for GFP culture. Scoping for project partners and investors was promoted through consultations with the national fisheries government agencies such as the National Inland Fisheries Technology Center of the Bureau of Fisheries and Aquatic Resources, and Laguna Lake Development Authority. These agencies expressed interest in the promotion of GFP culture but immediate participation was limited by lack of financial resources for this purpose. Meanwhile, on-farm site cage culture with the fish farmer cooperators from neighboring areas of BFS commenced by training the fish farmer cooperators at the BFS facilities. While the modality of the techno-demonstration project including the details of the Memorandum of Agreement between AQD and the cooperators have been prepared, season-long training would commence after the stocking of post larvae in the cages of the fish farmer cooperators.

The cooperative organized by the Municipal Agriculture Office in Dumarao was originally meant to serve as the modality for promoting tilapia grow-out for livelihood development. However, the inactiveness of such cooperative suggests the need to evaluate the limitations of cooperatives as a platform for introducing aquaculture technologies and sustaining livelihood development. Considering that when tilapia cage culture operations individually carried out in areas that are mostly privately-owned by the members of the inactive cooperative and other villagers proved to be successful, this could imply that the engagement of various project stakeholders in Dumarao becomes the possible modality to guaranty common understanding and participation, aside from the well-recognized need to pool scarce resources among stakeholders in a small farming municipality with limited financial resources, and still keep up with the present economic development.

In the promotion of grow-out culture for the freshwater giant prawn in Laguna Lake, partnership with fish farmer cooperators from three neighboring villages of BFS together with key barangay officials is the essence of the on-farm site demonstration study. Scoping for additional investors in this technology promotion project was conducted by contacting the national government fisheries agency and a semi-government corporation that manages the lake resources. However, financial constraints limit their commitments to immediately participate in the project spite of the interest demonstrated. The on-going MSECAP studies are anchored on the context of multi-agency collaboration to enhance technology dissemination and adoption to secure food and create aquaculture livelihoods. In all these alliances, SEAFDEC/AQD provides technical support and ensures the availability of the necessary aquatic juveniles produced from AQD facilities at subsidized cost to farmer-cooperators.

At the local level, government funds and human resources with expertise in fisheries and aquaculture may be limited but local government units (LGUs) have the command authority to mobilize local municipal resources, especially the natural aquatic resources. For example, sustainable aquaculture development in the Philippines is guided by the Philippine Fisheries Code of 1998 and the 1991 Local Government Code of the Philippines. LGUs could therefore serve as critical catalysts in the promotion of aquaculture technologies for rural livelihood development.

The aquaculture adoption pathway for capture fishers also support the MSECAP in adversely-affected coastal communities such as the municipality of Nueva Valencia in Guimaras Province and also in Sagay, Negros Occidental. Mariculture of milkfish has been promoted in Guimaras Province, central Philippines with people's organizations



Project collaborators in Guimaras construct fish cages for milkfish culture using bamboo frames

Box 7. Milkfish cage culture introduced to fishers affected by oil-spill in Guimaras Strait

An aquaculture technology adoption pathway for coastal communities is being developed in the municipality of Nueva Valencia in Guimaras Province in Western Visayas, which was affected by an oil-spill accident in 2006, as means of supplementing and providing alternative incomes for affected fishers. A coordinated support program participated by Citi-Petron, the municipal and provincial government of Guimaras, and SEAFDEC/AQD was instrumental in introducing cage culture of milkfish in two fishing villages in the Nueva Valencia. The cooperative way of operating cage culture of milkfish through peoples' organization (PO) has been the modality for conducting aquaculture in the two barangays. Moreover, *Taytaysa Kauswagan*, Inc. (TSKI), a non-government micro-finance institution, was tapped in 2010 to prepare and equip fisherfolk associations with enhanced skills to manage a sustainable community enterprise. Overall, milkfish cage culture generated positive incomes when the POs were under close supervision and training by SEAFDEC/AQD. When the POs operated their own fish cages in their respective areas, only one PO reported positive income where the technicians (caretakers) shared 80% of the profit as their wages while 20% went to the PO. The technicians claimed that their wages were reasonable considering that they work on rotation basis per week and still have time to go fishing or be involved in other livelihood activities. Meanwhile, the milkfish cage culture operations by the POs are on hold for review and assessment, while a new concept paper was submitted to the funding agency (Citi-Petron) to ensure the sustainability of the livelihood project. The establishment of a mariculture park in the area was also proposed with the qualified PO members targeted as adopters of the technology through a rent-to-own scheme. Furthermore, with the heightened interest on aquaculture as source of added income, the POs are waiting for the approval of their proposed sea cucumber grow-out culture project which was submitted to the Philippine Business for Social Progress (PBSP) for possible funding support. Some PO members showed interest in seeding their coastal waters with sea cucumber to enhance productivity, while claiming that it is not difficult to monitor the growth of sea cucumber and oversee the area since their coastal area is quite small.

(POs) to address emerging problems, specifically pollution caused by oil-spill as well as externalities from other industries. Thus, R&D allocations under the MSECAP have been based on the varied experiences of fisher-participants in their milkfish cage culture operations in Guimaras Province (Box 7).

Results of the study on milkfish cage culture suggested that organizational and management problems are the most challenging aspect of aquaculture technology adoption and delivery of impacts. The technology adoption pathway in oil-spill affected areas is especially developed for affected stakeholders in Guimaras Strait with the collaboration of Citi-Petron Foundation and the local government units in the study site. Mariculture of milkfish has been promoted as means of generating alternative livelihoods for the affected fishers.



Researchers work with fisherfolk in on-site sea cucumber cages in tidal flats to develop livelihood options while 'no take' regulations are in place during stock enhancement programs

Enhancement of threatened high-value marine species such as abalones and sea cucumbers in coastal communities in the Visayan Seas in Negros Occidental is also being carried out to determine the measures for alleviating depletion of aquatic resources due to overfishing and habitat degradation (**Box 8**). Results of the R&D studies have shown the adoptability and biological suitability of the hatchery and grow-out technology, as well as the preliminary resource

Box 8. Cage culture of abalone to complement livelihoods during "no-take" periods

Aquaculture of abalones in floating long-line cages is being tested in Brgy Molocaboc in Sagay, Negros Occidental in Western Visayas, Philippines. Aquaculture is meant to be a component of a stock enhancement program being implemented by SEAFDEC/AQD in collaboration with municipal and barangay government units. Thus, aquaculture of high-value abalones is being promoted to provide incomes to fishers participating in stock enhancement programs, considering that economic benefits from stock enhancement generally materialize after a long period of "no-take" fisheries management regime to allow rehabilitation of the enhanced stocks. Hence, an adoption pathway for aquaculture technology that generates incomes and livelihoods during resource enhancement and habitat rehabilitation programs is one of the action-oriented social science research studies, which is being conducted by SEAFDEC/AQD. Although the staggered releases of tagged hatchery-bred abalone juveniles in a community-based resource enhancement demonstration site showed positive results in terms of recaptures, growth and survival, the participation of the community in securing the community-based demo-sites against poachers has been challenged by expectations of immediate economic incentives among stakeholders, either in cash or in kind. Nonetheless, in order to facilitate the introduction of income-generating aquaculture livelihoods to fishers, members of the Barangay Fisheries and Aquatic Resources Management Council (BFARMC) who could serve as promoters for the culture of abalone as livelihood options, were trained in abalone and sea cucumber culture in SEAFDEC/AQD.

enhancement protocols developed by SEAFDEC/AQD. In Sagay, Negros Occidental for example, recapture of 4,000 tagged hatchery-bred abalone juveniles in a community-based resource enhancement site showed positive results. The average monthly growth rate of about 1.0 cm and high survival of the released abalones exhibited the suitability of introducing such technological protocols with indigenous knowledge to local fishers.

In order to encourage the participation of communities in securing community-based resource enhancement demo-sites against poachers, immediate economic incentives for stakeholders could be an option. Nevertheless, SEAFDEC/AQD tried to improve the technological capacity of fishers and members of the Barangay Fisheries and Aquatic Resources Management Council (BFARMC) by training them in abalone and sea cucumber culture at the AQD facilities in Tigbauan, Iloilo, Philippines. It is envisaged



BFARMC officers and members join and learn from researchers while monitoring abalone resource enhancement and cage culture livelihood demo-sites in Sagay, Negros Occidental



Hatchery-bred abalone juveniles transported in pipes during acclimation in study sites

that the technology on grow-out culture of abalone in trays in hanging long-lines could provide the livelihood options in lieu of immediate economic gains expected from resource enhancement activities.

The study in Sagay Marine Reserve in Negros Occidental which focuses on the development of strategies for managing enhanced stocks of abalone and sea cucumber, demonstrates and evaluates the role of collaboration between the community of fishers that directly participate and provide manpower to the project, the local government units and traders that provide logistics and governance support, and SEAFDEC/AQD that provides scientific and technical backing. Therefore, collaborative engagements for generating complementary culture-based livelihoods, such as grow-out of high-value abalones in marine cages during “no-fishing” regulations as a strategy in resource rehabilitation and enhancement periods, have been seen as the modality for addressing the need for enhancing incomes among participating stakeholders.

Aside from specific R&D studies being conducted under the MSECAP, SEAFDEC/AQD continues to conduct capacity building programs that facilitate the dissemination of aquaculture technologies for rural development in the Member Countries of SEAFDEC. These initiatives are intended to converge towards improving social and economic conditions of aquaculture stakeholders. For instance, a series of on-site training on mud crab farming and a regional training on community-based freshwater aquaculture for remote areas of Southeast Asia have been promoted in Myanmar and in the Philippines, respectively.

Control of fish diseases and the promotion of fish health under farming conditions are essential components of



On-site training on Freshwater Fish Health Management in Myanmar

aquaculture to ensure a stable supply of fish products. Hence, an important initiative of SEAFDEC/AQD in the region focuses on fish health management which is meant to accelerate the awareness of fish farmers in resource-deprived SEAFDEC Member Countries through industry-wide capacity building and research activities. An important component of this project is the implementation of regular training program on fish health management at AQD facilities in Iloilo, Philippines and on-site training in Member Countries with focus on the Mekong region, as well as through AQD’s biennial distance learning program on fish health management.

Concluding Comments

The MSECAP foresees that a direction towards an inclusive and holistic development of aquaculture in Southeast Asia can be realized by identifying and implementing various typologies of aquaculture technology adoption models suitable to the social and economic needs of the people of the region. This calls for specific strategies that will involve the integration of aquaculture technology adoption pathways in rural development planning and implementation.

The future directions could broadly include: (i) enhancing support for sustainable aquaculture in the national to local programs and policies; (ii) motivating governments to mainstream aquaculture in rural development; and (iii) applying precautionary and ecosystems approach in aquaculture. As distinctly specified in the *Resolution and Plan of Action* adopted during *ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security Towards 2020: Fish for the People 2020 “Adaptation*



AQD scientists conduct training course on mud crab farming in Myanmar, in collaboration with Department of Fisheries

to a Changing Environment” in June 2011, national programs and policies on aquaculture in the Southeast Asian countries should address the pressing social, economic and environmental aspects of sustainable aquaculture that directly impact rural development, *i.e.* aquaculture programs should contribute to improved food security, livelihoods, employment, and poverty alleviation. In particular, governments at all levels have been encouraged to integrate aquaculture into rural development planning within the context of multiple uses of land and water resources. Thus, inter-agency coordination is very crucial in policy formulation, project planning and implementation, stakeholder consultation, extension services, and technology transfer.

Mainstreaming aquaculture in rural development will require the participation of all concerned and support to regional initiatives that will assess the role of aquaculture in poverty alleviation for better policy formulation. In order to realistically integrate aquaculture activities in community development plans, compliance to national employment practices, facilitation of financial incentives and credit schemes, and promotion of investments in ancillary and other support structures to motivate aquaculture enterprises are necessary, as stipulated in the 2011 Plan of Action.

Public-private modalities to catalyze the integration of aquaculture in rural development are also crucial, while precautionary approach through the ecosystems approach to fisheries management being admonished by FAO in effect applies a preventative approach to safeguard the environment from rapid development of offshore aquaculture, and likewise consider development of a regional guidelines on responsible marine (inshore and offshore) aquaculture. In rural development scenarios, a precautionary and ecosystems principle will benefit protective and conservation measures that are critical in the practice of aquaculture in fragile environments. Ecosystems approach therefore beneficially magnifies the interconnectedness between the human and ecological dimensions in the utilization of natural resources in aquaculture to create an inclusive development, *i.e.* including those marginalized stakeholders during the early phases of aquaculture development in the region.

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