

New Challenges for Scientific and Technical Cooperation in Fisheries R&D: the SEAFDEC-FRA Partnership

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The Southeast Asian Fisheries Development Center (SEAFDEC) and the Fisheries Research Agency (FRA) of Japan have had a long history of partnership in the development of sustainable fisheries in the Southeast Asian region. After its establishment in 1967, SEAFDEC charted a linkage with the National Fisheries Research Institute (NFRI) of Japan for the formulation of R&D programs in fisheries for Southeast Asia, paving the way for the development of sustainable fisheries programs for the region. When the original centers of NFRI were drawn up into an independent body in 2001, henceforth known as the Fisheries Research Agency (FRA) of Japan, SEAFDEC re-activated and formalized its collaboration with FRA. Since then, several collaborative activities in fisheries development had been undertaken in the Southeast Asian region under the said partnership. However, it was not until 2004 that the formal five-year arrangement was signed between FRA and SEAFDEC, and five years later in 2009, the said collaboration was extended for another five years until 2014 marking a ten-year strong and sustained history of collaboration between SEAFDEC and FRA.

The Fisheries Research Agency (FRA) is among the first and original collaborating partners of SEAFDEC for the sustainable development of fisheries in the Southeast Asian region. With headquarters in Yokohama City, Japan (Fig. 1), FRA comprises ten research institutes and centers (Matsusato, 2014a), six (6) of which are regional institutes and four (4) specific field institutes/centers that are most relevant to the SEAFDEC-FRA collaboration, *i.e.* National Research Institute of Far Sea Fisheries (Shizuoka Prefecture), National Research Institute of Aquaculture (Mie Prefecture), National Institute of Fisheries Engineering (Ibaraki Prefecture), and Marine Fisheries Research and Development Center (Kanagawa Prefecture). From results of the research activities conducted at these institutes and centers, FRA published enormous quantity of technical and scientific papers. In a study conducted by Thomson-Reuters on scientific outputs, FRA ranked as the No. 1 agency with the most number of scientific papers in fisheries for the past 15 consecutive years from 1997 to 2011 (Matsusato, 2014a).

As soon as the initiated 10-year cooperation between SEAFDEC and FRA ended on 21 January 2014, the renewed Memorandum of Understanding (MOU) for Scientific and Technical Cooperation during 2014-2019 was signed on 23 January 2014 by the President of FRA, Dr. Toshihiko Matsusato on behalf of FRA and by SEAFDEC Secretary-General, Dr. Chumnarn Pongsri for SEAFDEC. The renewed MOU extends the technical and scientific cooperation between the two parties in order to strengthen the development of sustainable fisheries and aquaculture in the ASEAN countries through the programs and activities of SEAFDEC.



Fig. 1. Headquarters and research institutes/ centers of FRA in Japan (Adopted from Matsusato, 2014a)

The SEAFDEC-FRA Collaboration

Under the SEAFDEC-FRA collaboration, FRA provides technical assistance focusing on capacity building for SEAFDEC and the Southeast Asian countries, *i.e.* through research studies on special topics; improved information collection; publications; consultations including workshops, symposia, meetings; lectures on relevant emerging topics; awareness building; and training (**Box 1**). In terms of expertise, FRA dispatched 24 scientists to SEAFDEC and the Southeast Asian countries in 2013. The over-all number of scientists and staff dispatched by FRA since the start of the formal cooperation totaled 105 scientists/fisheries managers.

The cooperation had therefore enabled a number of staff from SEAFDEC and officers from the ASEAN Member States to boost their capacity in conducting research and development activities in various fields of fisheries and aquaculture. Meanwhile, exchange of expertise had been facilitated through the dispatch of FRA scientists to serve as research partners, lecturers, resource persons, as well as scientists/fisheries managers serving as Deputy Chiefs of SEAFDEC Departments ensuring sound technical management of these Departments. Through such collaboration, the capacity of SEAFDEC towards science-based development and management of fisheries

and aquaculture had been enhanced paving the way for the sustainable development of fisheries in the Southeast Asian region.

Challenges and the Way Forward

The renewed collaboration between SEAFDEC and FRA is expected to heighten the efforts of SEAFDEC in attaining sustainable fisheries development and food security, and for eradicating hunger and poverty in the Southeast Asian region. These efforts could contribute to deeper socio-economic integration in the region and subsequently comprise the concrete contribution of SEAFDEC towards the realization of the ASEAN Economic Community by 2015. Furthermore, the assistance of FRA of Japan under the SEAFDEC-FRA collaboration which focuses on capacity building is also envisioned to nail the gap of the wide disparity of development in fisheries and aquaculture among the countries in the Southeast Asian region. It is therefore, a great challenge for SEAFDEC to take advantage of the technologies already developed by FRA in Japan and adapt these to the region through joint R&D programs with FRA.

Under the renewed SEAFDEC-FRA cooperation, five areas of work have been identified by SEAFDEC for possible technical assistance from FRA (**Box 2**). These include: (1)

Box 1. Technical assistance provided by FRA under the SEAFDEC-FRA Collaboration (Adapted from Matsusato, 2014a)

1. Research on Special Topics

- *Aquaculture technology development including fish pathology*
 - Publication of manual on “Diseases of Cultured Groupers” (2004) with SEAFDEC Aquaculture Department (AQD)
 - Joint research on Larval Production of the Humphead Wrasse *Cheilinus undulatus* (2010) with AQD
- *Fish stock assessment and management*
 - Collection of information on Shark Fishery (CITES issue) with SEAFDEC Marine Fishery Resources Development and Management Department (MFRDMD)
 - Publication of “Sharks and Rays in Malaysia and Brunei Darussalam” (2005) with MFRDMD and Department of Fisheries (DOF) Malaysia
 - Workshops on Artificial Reefs co-sponsored with MFRDMD and DOF Malaysia: Kuala Lumpur (2009), Bangkok (2009), Tokyo (2010)
 - Resource persons provided during the Training on Juvenile Tuna Identification at SEAFDEC/MFRDMD
- *Energy saving in fishing boat operations*
 - Resource persons and lecturers provided during On-site Training on Energy Savings in Small Fishing Boats organized by SEAFDEC Training Department (TD) in 2013 in Thailand, Vietnam, Myanmar
- *Seafood safety and food processing*
 - Resource persons and lecturers provided during the Training on Analysis of Shellfish Poisoning at SEAFDEC Marine Fisheries Research Department (MFRD)
- *Fishery management and economic research*
 - Awareness building through poster presentation on “Fisheries Co-management in Japan” with SEAFDEC Secretariat at Kasetsart University, Bangkok, Thailand (2014)

2. Exchange of Expertise

- *Dispatch of scientists/fisheries managers*
 - 24 scientists dispatched to SEAFDEC and Southeast Asian countries in 2013
 - A total of 105 scientists dispatched to SEAFDEC and Southeast Asian countries
 - 6 management staff dispatched to AQD and MFRDMD to serve as Deputy Department Chiefs while working as scientists/researchers

3. Human Resource Development

- *Training in Japan*
 - 5 trainees from SEAFDEC Departments accepted by FRA in 2013 (including those sponsored through Marino Forum 21)
 - Sponsored a total of 20 SEAFDEC staff and officers from ASEAN countries to train in Japan, since the start of SEAFDEC-FRA cooperation

Box 2. R&D areas identified by SEAFDEC and proposed to FRA for technical assistance under the renewed SEAFDEC-FRA Collaboration

<i>R&D areas proposed by SEAFDEC to FRA for technical support</i>	<i>Remarks from FRA</i>
<p>1. Stock assessment and enhancement of species with decreasing stock sizes</p> <ul style="list-style-type: none"> • Stock assessment and fishery management: the use of TAC System (MFRDMD) • Genetic analysis of population and DNA barcode studies (MFRDMD) 	<ul style="list-style-type: none"> • Ongoing, FRA technical support to be continued • FRA technical support to be continued but study should also include DNA barcode for some commercially-exploited or endangered aquatic species
<p>2. Fish stock management with improved catch data compilation</p> <ul style="list-style-type: none"> • Responsible fishing and sustainable fisheries management (TD) • Improving fish handling on-board small fishing vessels (TD) 	<ul style="list-style-type: none"> • Research studies on reduction of by-catch technology and discards and on development of technology in reducing manpower in fishing operations, are relevant to the region, thus, the project is being considered for possible FRA support • Research on reduction of impacts of fishing to the coastal and marine environment might not be practical and needs thorough review • Could be carried out through the development of selective gears that target particular species, e.g. net design that catch only particular size/species of fish
<p>3. Sustainable fisheries that sustain biodiversity and coastal environment</p> <ul style="list-style-type: none"> • Artificial reefs project (MFRDMD) • Energy/fuel saving for fishing vessels/operations (TD) 	<ul style="list-style-type: none"> • Ongoing, FRA technical support to be continued • Research studies on appropriate design and techniques of fuel saving in fishing vessels and fishing operations, and on the use of LED for light fishing are relevant for the region, thus, being considered for FRA support • Research study on alternative energy/fuel used in fishing vessels/engines might not be practical in actual fishing operations since filling of LPG and NGV for fishing vessels may not be possible in actual situations in Southeast Asia
<p>4. Aquaculture technology using artificially-raised juveniles</p> <ul style="list-style-type: none"> • Climate-resilient abalone ranching for small-scale fishers using hatchery-bred juveniles (AQD) • Aquaculture technology adoption pathways in Southeast Asia: study sites in Pampanga and Aklan in the Philippines; and in Vietnam and Myanmar (AQD) • Establishment of environmental manipulation/methods to develop boneless milkfish through suppression of intramuscular bone formation 	<ul style="list-style-type: none"> • Released spats might not contribute to the ability of species to undergo natural spawning and FRA is still establishing the reasons behind this. Moreover, studies on climate-resilient aquaculture should consider species that are tolerant to high temperature levels • Being more of a regional activity, FRA could provide support through the extension of particular relevant technologies • May not be very practical, however, adaptation of technology used in Japan, e.g. fish bone removal machine could be more suitable
<p>5. Development of vaccines against fish diseases for food safety</p>	<ul style="list-style-type: none"> • <i>Specific activity to be identified later</i>

stock assessment and stock enhancement research on species with stock sizes that are alleged to be decreasing to protect these resources from declarations outside the fisheries sector that restrict the fisheries of such resources (e.g. species related to CITES); (2) fish stock management based on more detailed catch data compilation; (3) development of fisheries technologies that sustain biodiversity and the coastal environment; (4) aquaculture technology that does not reduce wild stocks, i.e. aquaculture using artificially-raised juveniles; and (5) development of vaccines against fish diseases for food safety. Considering that FRA is a research agency with budgetary allocations mainly for R&D programs (Matsusato, 2014b), SEAFDEC would

formulate the research project proposals for cooperative work with FRA taking into consideration the aspects on institutional property rights (IPR) in the development of such proposals.

Further to the above remarks, the R&D areas that are being considered for technical assistance from FRA are aimed at ensuring stable supply of fishery products and developing robust fisheries industries in the Southeast Asian region (Matsusato, 2014b). In this regard, SEAFDEC is therefore developing joint R&D projects that promote technology development in order to attain such goal. Since FRA could also provide technical assistance on research initiatives

not only targeting stable supply of fishery products but also securing safety of fishery products, SEAFDEC is therefore taking advantage of the opportunity to learn from the experiences on FRA in fisheries R&D.

Experiences of FRA that could be adopted by SEAFDEC in promoting sustainable fisheries and aquaculture development in the Southeast Asian region

With the onset of sustainable tuna management, the consequences of the technical assistance of FRA under its partnership with the Western and Central Pacific Fisheries Commission (WCPFC) could be learned by SEAFDEC. Specifically, SEAFDEC could avail of FRA expertise in analyzing various measures to promote tuna conservation, *i.e.* reducing the mortality of the bigeye tuna in fishing, and introducing the new and basic concept of controlling fishing effort, as well as in analyzing the impacts of the possible closure of FADs (Nakayama, 2014). As member of the WCPFC Scientific Committee, Japan through FRA is committed to compile and provide information on Japanese fishery and research to the WCPFC; provide standardized CPUE of Japanese fisheries as key indices for the stock assessment; conduct projects on tagging in the sub-tropical and temperate waters; develop new mitigation method of juvenile tunas catch on purse seine FADs operation; develop guidelines for the safe release of encircled whale shark by purse seine operation; develop and evaluate practical seabird mitigation methods; and collect tuna biological samples from Japanese markets. Such concerns could serve as models for SEAFDEC in formulating activities under its fisheries conservation projects for the sustainability of tuna resources in the Southeast Asian region.

SEAFDEC could also take up the recommendation of FRA for the development of appropriate cooperative management among relevant countries of Southeast Asia for the sustainable utilization of neritic tuna stocks based on scientific evidence. Neritic tunas are not appropriately managed under international cooperation in view of their characteristics as being evidently shared stocks among countries, especially in the Southeast Asian region (Nakayama, 2014). Considering that SEAFDEC has recently embarked on the Development of the Regional Plan of Action on Sustainable Utilization of Neritic Tunas in the ASEAN Region or RPOA-Neritic Tuna (SEAFDEC, 2014), the concerns of FRA on the sustainability of neritic tuna stocks could be useful in the development and promotion of the RPOA-Neritic Tuna in Southeast Asia.

Moreover, the experience of FRA in addressing concerns on the sustainability of cultured marine fish stocks could be grasped by SEAFDEC, especially with regards to

controlling the viral nervous necrosis (VNN) infection in grouper. As reported by Nishioka *et al.* (2014), a variety of marine fish species, especially the economically-important grouper species, is affected by VNN caused by betanodaviruses, and their findings point to the fact that VNN occurs seriously during the seed production stage of grouper aquaculture. The FRA study made use of the long-tooth grouper *Epinephelus bruneus*, an economically-important marine fish, which inhabits the reef and coral areas of about 50 meters deep and substantially grows to marketable size.



Long-tooth grouper, *Epinephelus bruneus*

Following the protocols in the seed production of striped jack, virus free long-tooth grouper broodstock was selected based on PCR tests and naturally spawned fertilized eggs were placed in ozonated seawater. After hatching, the larvae and juveniles were reared with charcoal-treated ozonated seawater. As with the VNN control measure for striped jack, grouper sperm and eggs were cleaned, sperm activity and hatching rate of eggs examined including the level of virus removal. The sperms were placed on Percoll discontinuous gradients and centrifuged, then collected from the sperm-rich fraction beneath the 25% Percoll layer. While the results indicated 82% virus removal rate, cleaning did not influence the sperm activity and hatching.

FRA has also developed a vaccine which is now available on commercial scale, to control VNN infections in marine fish species. Although it has been found that VNN occurs mostly at early developmental stages, larvae or juveniles, but some fish species such as groupers and sea bass are susceptible to betanodaviruses even at the young and older stages (Mori *et al.*, 2014).

Another most valuable marine fish species for aquaculture is the seven-band grouper *Epinephelus suptemfasciatus* which is highly susceptible to VNN infection even at grow-out stage. Records have shown that mass mortalities of this seven-band grouper could exceed 50% in net-pen aquaculture especially during the summer months. The effect of VNN on the fish could be characterized by upside down swimming with inflation of the swim bladder.

A vaccination project was therefore carried out by FRA from 2006 to 2008. This included studies on determining the vaccine strain, selecting vaccine candidate-fishes, establishing the effective vaccine dosage, and field-testing



Seven-band grouper *Epinephelus suptemfasciatus*

of vaccine developed (Mori *et al.*, 2014). Results of the project pointed towards two injection vaccines that were found effective in inducing the protective immunity in seven-band grouper, *i.e.* recombinant vaccine and formalin-inactivated vaccine.

Although the recombinant vaccine is easy to prepare on a large scale, a booster injection is necessary to induce sufficient protection that must be a disadvantage in commercial vaccination practices. As a result of such disadvantage, formalin-inactivated vaccine was selected as a candidate. In the immunization experiment with different injection routes, *i.e.* intramuscularly (IM) or intraperitoneally (IP), the neutralizing antibodies were detected both in the immunized groups and there was no significant difference in the titers, although intraperitoneal route is preferable to prevent solution's leak in the injected sites (Mori *et al.*, 2014). Based on the successful results from the field-testing experiments in 2008, the official approval for production and sale of the vaccine in Japan was obtained in 2012. The vaccine is now available on commercial scale in Japan and its distribution worldwide is expected to stabilize the aquaculture of groupers and increase the production of such economically-important aquaculture species.

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