FISH for the PEOPLE

A Special Publication for the Promotion of Sustainable Fisheries for Food Security in the ASEAN Region
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Securing safe and sustainable fish and fishery products through food and aquaculture technologies and alleviation of small-scale fisheries in the Southeast Asian region

SEAFDEC Southeast Asian Fisheries Development Center

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Editorial

This issue of the Fish for the People highlights the activities of SEAFDEC on ensuring food safety and quality of fish and fishery products by developing and promoting technologies that ensure high quality, healthy, and safe fish and fishery products to meet international standards. The other activities that are featured in this issue include gender integration in fisheries, community-based resource management, and financial services for small-scale fishers which are identified as cross-cutting issues by the Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2030 (RES&POA-2030). Furthermore, this issue also presents the ongoing investigation of alternatives to fish meal in feed formulation and promoting the economical use of feeds specifically for mangrove crab.

From catch to consumer, good handling practices and processing technologies are crucial to safeguard the freshness and safety of fish and fishery products by extending shelf life as well as maintaining nutritional quality and economic value. Therefore, Strategy 3 of the Resolution on the Future of SEAFDEC adopted in 2017 specified "*Ensuring the food safety and quality of fish and fishery products for the Southeast Asian region*" through the "*Development and promotion of technology to produce high quality, healthy and safe fish and fishery products to meet the international standards*." In order to address the perishable nature and maintain the quality and safety of fish and fishery products, the SEAFDEC Marine Fisheries Research Development developed good handling practices through high-pressure processing (HPP) which is an emergent food processing and preservation technique that extends shelf life without altering the nutritional and health attributes of food products under the project "Enhancing Food Safety and Competitiveness of Seafood Products" from 2020–2024 with support from the Japanese Trust Fund (JTF). Facilitating international collaboration and knowledge sharing to leverage global expertise and experiences in the application

Editor in Chief (Fish for the People)

SEAFDEC Secretariat
Kasetsart University Campus
P.O. Box 1046, Kasetsart Post Office
Bangkok 10903, THAILAND
E-mail: fish@seafdec.org

of HPP to different fish species and cultural preferences will increase acceptance in global markets.

The RES&POA-2030 also recognizes the importance of cross-cutting issues including small-scale fisheries, labor in fisheries, safety at sea, and gender equality in the fisheries and aquaculture sector. Focusing on gender, for several years, SEAFDEC has been striving to mainstream and integrate gender within the organization as well as in its programs and projects. Since the early 2000s, SEAFDEC implemented numerous projects throughout the Southeast Asian region with activities including training courses, studies, awareness-raising, and capacity-building, *e.g.* under the project "Gender Dimension in the Value Chain of Small-scale Fisheries and Aquaculture in Southeast Asia" with a series of gender analyses conducted in Philippines, Thailand, Myanmar, and Lao PDR. For the promotion of sustainable small-scale fisheries, activities were undertaken under the project "Facilitating Fisheries Activities Information Gathering Through Introduction of Community-based Resources Management/Co-management" with activities in Nam Xouang Reservoir, Lao PDR to engage and empowere the women in the Nam Xouang Reservoir who now have enhanced their knowledge and skills in fish processing and earn higher incomes. Moreover, under the project "Small-scale Fisheries Management for Better Livelihood and Fisheries Resources," an socioeconomic survey was conducted in Ranong Province, Thailand focusing on promotion of financial services schemes for small-scale fishers.

Lastly, the Resolution on the Future of SEAFDEC adopted in 2017 incorporates Strategy 2 "*Supporting the sustainable growth of aquaculture to complement fisheries and contribute to food security, poverty alleviation and livelihood of people in the region*" by "*Finding alternatives to fish meal in feed formulation and promoting the economical use of feeds*." In order to support the sustainability of the mangrove crab industry in Southeast Asia, there is a need to produce an efficient and viable aquaculture feed for this species. The SEAFDEC Aquaculture Department worked on the improvement of feed formulation with the inclusion of ingredients that are less expensive based on published nutritional requirements and physical properties of mangrove crab. The study was conducted to assess the efficiency of the refined crab feed in land-based tanks which focused on partial replacement of fishmeal with alternative ingredients such as mussel meat meal to improve molting processes affecting the growth of the animal. Results indicated that refined crab feed can potentially be used as sole feed for the grow-out culture of this species as it can enhance its growth and survival in tanks.

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Revolutionizing Seafood Safety and Sustainability: ensuring safe seas to plates

Gan Heng Hui

Keywords: fishery products, food safety, high-pressure processing, non-thermal processing, shelf-life extension

Fisheries and aquaculture are some of the key industries in the Southeast Asian region, not only supplying fish and fishery products to the local demand but also exporting worldwide to meet the growing demand for seafood. However, the perishable nature of seafood poses challenges in maintaining its quality and safety. Hence, there is a need to develop good handling practices and reputable technologies that would mitigate the high microbiological risk while retaining the high nutritional content. Rapid deterioration of quality due to irreversible processes such as microbiological metabolism, oxidative reactions, and enzymatic activity take place soon after the capture and/or harvest of seafood. From catch to consumer, good handling practices and processing technologies are crucial to safeguard the freshness and safety of seafood products by extending shelf life as well as maintaining nutritional quality and economic value.

In this regard, Strategy 3 of the Resolution on the Future of SEAFDEC adopted in 2017 specified "*Ensuring the food safety and quality of fish and fishery products for the Southeast Asian region*" through the "*Development and promotion of technology to produce high quality, healthy and safe fish and fishery products to meet the international standards*." Therefore, SEAFDEC Marine Fisheries Research Development (MFRD) implemented the project "Enhancing Food Safety and Competitiveness of Seafood Products" from 2020–2024 with support from the Japanese Trust Fund (JTF). The Project aims to develop the Regional Guidelines on Good Manufacturing (GMP) and Handling Practices (GHP) for Ready-to-Eat Raw Fish and Fishery Products as well as High-Pressure Processing (HPP) Protocols for Seafood.

What is High-Pressure Processing (HPP)?

From the moment a fish is caught to its journey to your plate, stringent measures and best practices that safeguard our seafood supply chain and protect consumers are set in place. The fundamental guidelines that ensure that the fish you savour is not only delicious but safe for consumption, shall be published in the upcoming Regional Guidelines which are aligned with international standards. Local seafood processers' capabilities can be strengthened in handling high-risk seafood products, such as ready-to-eat raw fish and fishery products, ensuring these products are consistently produced and controlled according to quality and safety standards. Best practices for quality assurance in handling, processing, storage, transportation, and retail of raw fish and fishery products (**Figure 1**) can then be adopted.

Prevailing traditional food preservation techniques, like thermal processing, render seafood extended shelf-life at the cost of loss of original flavour, taste, appearance, colour, and nutritional quality (Ohlsson *et al*., 2013). Safety is often prioritized over sensorial quality in thermal processing. Consumers today expect the foods purchased and consumed to be not only safe but of high quality, providing sensory characteristics such as taste, aroma, palatability, and appearance (**Figure 2**).

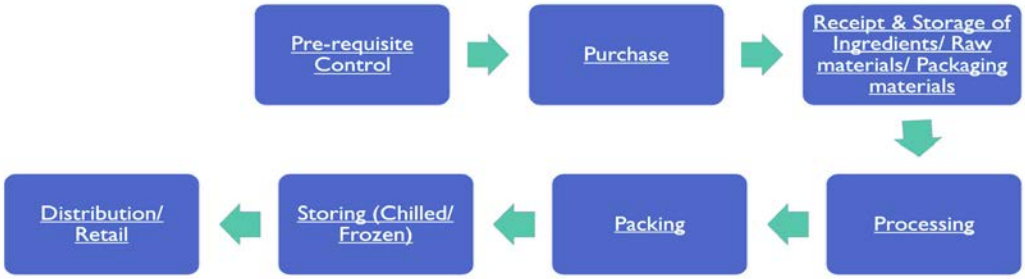

Figure 1. Process flow for handling of ready-to-eat raw fish and fishery products

Figure 2. Pan-fried salmon with asparagus and mash

High-pressure processing (HPP) is an emergent food processing and preservation technique that extends shelf life without altering the nutritional and health attributes of food products (**Figure 3**). It is also called high hydrostatic pressure (HHP) processing and has had various applications with fish and shellfish products over the years. The technology's high pressures destroy or inactivate microbial cells in seafood to improve shelf life, quality, and food safety. As a non-thermal preservation technique, HPP preserves the heat-sensitive sensorial properties (flavour and aftertaste) due to the absence of heat treatment. In HPP, a high hydrostatic pressure (between 100 and 1000 MPa) is applied to food material consistently and simultaneously from all directions which will eventually destroy the detrimental microbes and indigenous enzymes by providing the pasteurization effect without thermal treatment. This technique can be effectively applied to both liquids and solid foods with comparatively higher moisture content (**Box**). Essentially, the objective of introducing HPP is to make high-quality fish accessible to all.

Figure 3. High-pressure processing equipment in a tolling facility in Singapore

Box. Some of the advantages of high-pressure processing (Campus, 2010)

- Increased yield from seafood especially crustaceans and molluscs (Murchie *et al*., 2005), where shucking and extraction of crustacean meat could be done effortlessly after HPP
- Foods are rendered free of pathogenic and spoilage organisms, whereby *Vibrio* species detected in control, unprocessed crabs were no longer detected in HPP-processed one
- Improvement of shelf life, while microbial load of HPP-processed seafood was still within Singapore Food Regulations Eleventh Schedule microbial limits after chiller storage of these seafood up to 19 days, demonstrating an extension to existing seafood products which are often tagged with not more than seven days shelf-life
- Retention of nutrition, color, and flavor since HPP imparts less effect on low molecular-weight compounds such as vitamins, color pigments, and high volatile flavoring compounds as compared to ultraheat treatment
- Value addition like convenience with the development of new product ranges such as natural/ fresh-like ready-to-eat fishery products
- Reduction of processing time

In collaboration between MFRD and Nanyang Polytechnic, the preliminary trials were carried out on local seafood products (red grouper fillet, squid rings, green mussels, *Vannamei* prawns, and mangrove crab) (**Figure 4**). The trial demonstrated the inactivation of microbial spoilage, verified the improvement of the shelf life of these seafood products (**Table 1**), and value-added these with the conception of a new ready-to-eat (marinated) fish fillet.

Figure 4. Seafood products before being processed in HPP for the preliminary trial

Table 1. Comparison of microbial results of HPP-processed at 5,000 bar, 180 sec of seafood and non-HPP processed control seafood products at Day 0 and Day 19 (EB: Enterobacteriaceae, EC: *Escherichia coli*, Sal: *Salmonella*, VP: *Vibrio parahaemolyticus*, LM: *Listeria monocytogenes*, ND: Not Detected; D: Detected)

Pressure (bar) at 180s	Seafood product	EB (CFU/g)	EC (CFU/g)	Sal (per 25g)	VP (per 25g)	LM (per 25g)
5,000 (Day 0)	Fish	<10	<10	ND	ND	ND
	Squid	<10	<10	ND	ND	ND
	Mussel	<10	<10	ND	ND	ND
	Prawn	<10	<10	ND	ND	ND
	Crab	<10	<10	ND	ND	ND
5,000 (Day 19, stored in chiller)	Fish	<10	<10	ND	ND	ND
	Squid	<10	<10	ND	ND	ND
	Mussel	360	<10	ND	ND	ND
	Prawn	<10	<10	ND	ND	ND
Control (Day 0, non-HPP)	Fish	420	<10	ND	ND	ND
	Squid	80	<10	ND	ND	ND
	Mussel	640	60	ND	ND	ND
	Prawn	320	<10	ND	ND	ND
	Crab	200	<10	ND	D	ND

Effect of HPP on Protein

In general, covalent bonding is not affected by pressure processing, with the exception of sulfhydryl groups and thiol-disulphide interchange reaction. Primary structure of large molecule is minimally affected by pressure (**Figure 5**). HPP modifies secondary, tertiary and quaternary structure of proteins (Kato *et al*., 2002). Small molecules like vitamins, flavour compounds allow preservation of nutritional value and sensory appeal (Linton *et al*., 2002).

Effect of HPP on microorganisms

Microbe's cells are inactivated in HPP due to a combination of certain factors (Simpson & Gilmour, 1997) like changes in cell membranes and cell walls; and changes in proteins and enzyme-mediated cellular function (**Figure 6**). It has been said for microbial inactivation by HPP, *Staphylococcus aureus* (cocci) is more resistant to pressure but rod-shaped pathogenic bacteria like *Escherichia coli*, *Pseudomonas aeroginosa*, and

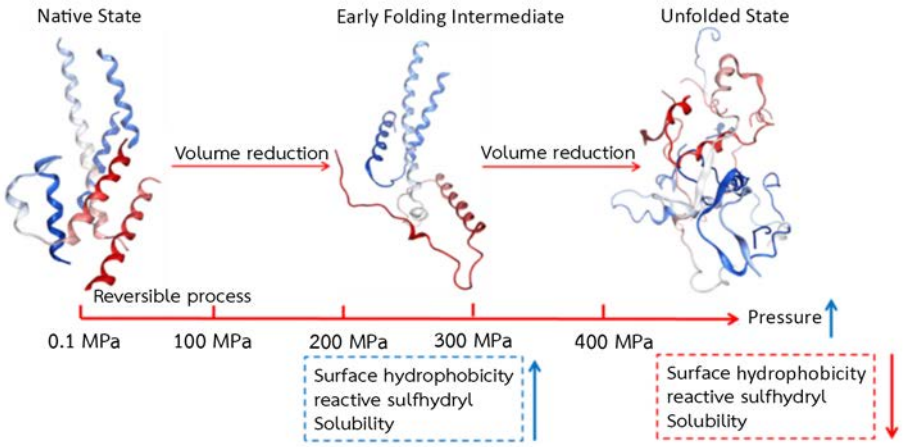

Figure 5. Schematic diagram of the mechanism of pressure-induced protein denaturation (MDPI Foods, 2021)

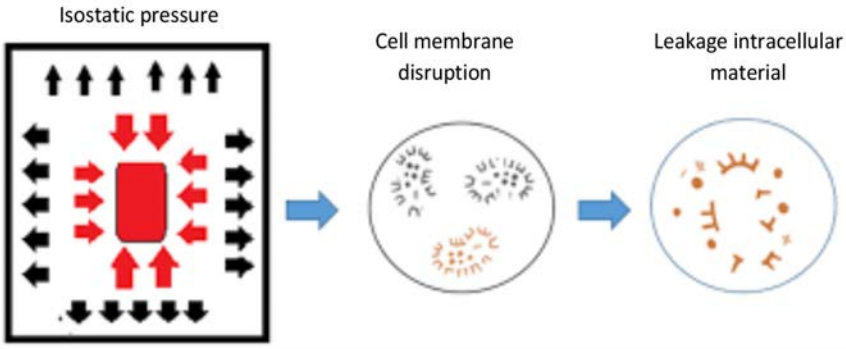

Figure 6. Bacterial inactivation by HPP (Food Research, 2021)

Listeria monocytogenes change their morphology under HPP (Ludwig & Schreck, 1997).

Effect of HPP on colour and texture of the seafood muscle

When fish with red and white muscles are pressurized, the muscle tissue becomes opaque. The effect is similar to that of boiling or grilling with increasing pressures and holding times. Therefore, the fish obtains the characteristics of a cooked, rather than fresh, product. This color change may not be perceived by consumers as desirable; thus, there is a need to develop a new ready-to-eat alternative for such fish products. Furthermore, high pressure can affect molecular interactions (hydrogen bonds, hydrophobic interactions, and electrostatic bonds) and protein conformation leading to protein denaturation, aggregation, or gelation (Messens *et al*., 1997) (**Figure 7**).

Figure 7. Fish fillet before *(left)* and after *(right)* HPP

Building the capacity of the AMSs on HPP

The Project commenced in October 2020 with the inception meeting conducted virtually due to travel restrictions brought about by the COVID-19 pandemic. The scope for both tracks of the Project was discussed and agreed upon by the ASEAN Member States (AMSs).

The virtual training "Good Manufacturing and Handling Practices (GMP & GHP) for Ready-to-Eat Raw Fish and Fishery Products" was conducted in April 2022 with representatives from the AMSs. Subsequently, the AMSs were required to carry out pilot trials on GMP and GHP for ready-to-eat fish and fishery products in their respective countries.

In June 2023, the "Mid-Term Review Meeting for Track I: Regional Guidelines on Good Manufacturing and Handling Practices (GMP & GHP) for Ready-to-Eat Raw Fish and Fishery Products" was held in Singapore (**Figure 8**). During the Meeting, the respective AMSs reported the current food safety guidelines for the safe handling and processing of raw fish and fishery products. They shared their experiences and findings during the trial period (*e.g.* monitoring and enforcement of implementation, hesitancy of fishery establishments adapting food safety measures and difficulty implementing the guidelines in local small scale fishery companies). Being aware of the importance of GMP and GHP in guaranteeing the safety and quality of raw fish and seafood, the respective AMSs are currently adhering to country-specific hygiene requirements, food safety assurance programs, and food safety policies.

Figure 8. Participants in the "Mid-Term Review Meeting for Track I: Regional Guidelines on Good Manufacturing and Handling Practices (GMP & GHP) for Ready-to-Eat Raw Fish and Fishery Products" in Singapore in June 2023

Furthermore, the "High-Pressure Processing (HPP) Training Workshop" was held in June 2023 at Nanyang Polytechnic in Singapore (**Figure 9**). The Training covered the basics of HPP for seafood, HPP parameters for seafood products (*i.e.* crab, red grouper fish, *Vannamei* prawn, squid ring, and mussels), and raw seafood and marinated seafood. A trial run at an HPP facility in Singapore (**Figure 10**) was also included in the Training for the participants to observe the changes after the seafood was processed in HPP.

Figure 9. Participants in the "High-Pressure Processing (HPP) Training Workshop" at Nanyang Polytechnic in Singapore in June 2023

Figure 10. Visit to a HPP facility in Singapore for the participants in the "High-Pressure Processing (HPP) Training Workshop" in June 2023 to observe the changes after the seafood is processed in HPP in Singapore

MFRD would publish a handbook on HPP of fish and fishery products which will include procedures for HPP of fish and fishery products (such as fish meat, oyster, lobster, crabmeat, cooked shrimp, etc.) to add value and extend the shelf life of these products, benefiting both consumers and the industry. Consumers will have access to better quality and safe products that retain their natural flavour, colour, and texture, while the industry will benefit from the extended product shelf life, resulting in less loss due to expired products and the ability to sell or export products to markets further afield. Once completed, the handbook will be disseminated to the AMSs during the End-of-Project Meeting in 2024. Soft copies of the handbook will also be made available via the SEAFDEC website.

Way Forward

More research should be carried out on local seafood products to explore the opportunities that HPP can bring to a broader range of seafood varieties, including delicate fish species, to understand the impact on texture, taste, and shelf life. There is more room in investigating and optimizing pressure-time profiles to achieve the desired pathogen reduction while minimizing any adverse effects on the sensory attributes of fish

products. Shelf-life enhancement can be further studied for synergies with other preservation methods, such as modified atmosphere packaging (MAP) or natural antimicrobials, to develop comprehensive preservation strategies that improve both safety and quality.

More deliberate research and development can create innovative HPP-treated fish products that cater to evolving consumer preferences, such as convenient and healthy seafood snacks. Understanding the science behind HPP and its transformative impact on fish preservation, safety, and sustainability will help expand the optimization of this technology for the sustainable management and development of fisheries in the region. Increased adoption and larger-scale production facilities could contribute to economies of scale, to reduce the overall cost of HPP equipment and processing. At the same time, it is critical to assess and minimize the environmental impact of HPP processes, including energy consumption and waste generation, to align with sustainability goals.

The future of HPP in the fish and fishery products industry lies in the continuous refinement of techniques, collaboration across the value chain, and a commitment to addressing consumer expectations, regulatory requirements, and sustainability considerations. Facilitating international collaboration and knowledge sharing to leverage global expertise and experiences in the application of HPP to different fish species and cultural preferences will increase market acceptance in key seafood-consuming regions globally.

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About the Author

Dr. Gan Heng Hui is a Senior Specialist in Food Chemistry and Safety from Nanyang Polytechnic School of Applied Sciences (Email: gan_heng_hui@nyp.edu.sg). *Dr. Heng Hui* stands at the forefront of dynamic research and innovation in the domains of food safety and sustainability. She has been instrumental in driving advancements in the food industry and played a pivotal role in propagating innovations. She is one appointed consultant for reviewing food labels, leading the Food Safety Centre, and providing food safety consultancy to the food industry of the Singapore Food Agency.

Striving to Mainstream and Integrate Gender in Small-scale Fisheries of Southeast Asia:
SEAFDEC initiatives on gender through the years

Jariya Sornkliang

Keywords: gender equality, gender in fisheries, SEAFDEC Gender Strategy, women empowerment

The Southeast Asian Fisheries Development Canter (SEAFDEC) is an autonomous inter-governmental body established in 1967 with the vision of "*Sustainable management and development of fisheries and aquaculture to contribute to food security, poverty alleviation and livelihood of people in the Southeast Asian region*." Moreover, SEAFDEC is supporting the ASEAN Member States (AMSs) to implement the Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2030 (RES&POA-2030) (SEAFDEC, 2020b), which serves as a policy framework and includes priority actions to support the sustainable development of fisheries and enhancing the contribution of fisheries to food security and better livelihood of people in the region. The RES&POA-2030 recognizes the importance of and addresses the cross-cutting issues in the fisheries and aquaculture sector, including small-scale fisheries, labor in fisheries, safety at sea, and gender equality. Focusing on gender, women's roles are not well recognized particularly in the small-scale fisheries sector of the Southeast Asian region. In this regard, SEAFDEC strived in the development and implementation of programs, projects, and activities that engage both women and men in the planning, implementation, monitoring, and evaluation processes.

Gender concepts

Gender equality and women empowerment have been promoted since the feminist movement for women's rights in 1945 and were emphasized in the fisheries and aquaculture sector through the FAO Voluntary Guidelines for Securing Sustainable Small-scale Fisheries in the Context of Food Security and Poverty Eradication (SSF Guidelines) in 2014 (**Box 1**). The SSF Guidelines recognize the vital role of women in small-scale fisheries, equal rights, and opportunities and that achieving gender equality requires gender mainstreaming as an integral part of all small-scale fisheries development strategies.

The difference between sex and gender and other gender concepts (SEAFDEC, 2020a) are described in **Box 2**. Sex does not change and being male/female refers to biological attributes that are fixed at birth. The most significant sex differences in humans are related to menstruation, pregnancy, breastfeeding in females, and the production of sperm in males. Gender changes over time and refers to the

Box 1. International frameworks on gender

- **1945:** United Nations Charter reaffirms the fundamental human rights in the equal rights of men and women
- **1948:** Declaration on Human Rights opposes discrimination against women
- **1952:** International Convention on the Political Rights of Women was the first global endorsement of equal political rights under the law
- **1979:** Convention on Elimination of all Forms of Discrimination Against Women (CEDAW) where gender equality was promoted
- **1995:** Beijing Declaration: Obligation for Gender Equality internationally adopted Gender mainstreaming was a critical strategy towards making gender equality during the 4th World Conference on Women, Beijing, China
- **2000-2015:** United Nations Millennium Development Goals (MDGs) with Goal No. 3 "Promotion of Gender Equality and Empower Women"
- **2014:** FAO Voluntary Guidelines for Securing Sustainable Small-scale Fisheries in the Context of Food Security and Poverty Eradication (SSF Guidelines) is the main instrument that promotes gender equality and equity as fundamental to any development
- **2015-2030:** United Nations Sustainable Development Goals (SDGs) with Goal No. 5 "Achievement of gender equality and empowerment of all women and girls"

Box 2. Gender concepts

Sex: The biological characteristics that distinguish human beings as female or male.

Gender: A concept that refers to the social differences between women and men that have been learned, are changeable over time, and have wide variations both within and between cultures

Gender equality: Gender equality is the concept that all human beings are free to develop their abilities and make choices without the limitations set by strict gender roles; that the different behaviors, aspirations, and needs of women and men are considered, valued, and favored equally

Gender equity: Fairness in women's and men's access to socioeconomic resources (*e.g.* access to education depends on whether the child is a boy or girl) and it is a condition in which women and men participate as equals and have equal access to socioeconomic resource

Gender mainstreaming: A strategy for making women's as well as men's concerns and experiences an integral dimension in the design, implementation, monitoring and evaluation of programs/projects in all political, economic, and social spheres. Therefore, women and men benefit equally, and inequality is not perpetuated. The ultimate goal is to achieve gender equality

sociocultural attributes of men and women varying from one society to another. Gender also refers to the relations between men and women and the socially constructed roles acceptable for each sex. Femininity and masculinity are from social construction which reveals that men have more respect than women in society, then women are lower hierarchy than men in economic social, and political women face this society called patriarchy. Therefore, gender mainstreaming is needed in order to promote and achieve gender equality through equity. Gender mainstreaming can be done in the organization, project/program, and activities by using different tools (SEAFDEC, 2020a) as shown in **Box 3**.

Box 3. Gender mainstreaming tools

Gender analysis: A critical examination of how differences in gender roles, activities, needs, opportunities and rights/entitlements affect women, men, girls, and boys in certain situation or contexts. It includes the collection and analysis of sex-disaggregated information and the study of the different roles of women and men, and the relation between and among them. It is thus a tool that assists planners in developing, implementing, and monitoring and evaluation of programs/projects to become effective, efficient, and equitable

Sex-disaggregated data: The collection and separation of data and statistical information by sex to enable comparative analysis, sometime referred to as gender-disaggregated statistics

Gender-responsive budgeting: Government planning, programming, and budgeting that contribute to the advancement of gender equality and the fulfillment of women's and men's rights. It is not about creating separate budgets for women/men, or solely increasing spending on women's/men's programs/projects. Rather, it seeks to ensure that the collection and allocation of public resources are carried out in ways that contribute to advancing gender equality and women's/men's empowerment

SEAFDEC: a gender-responsive organization

Small-scale fisheries are the dominant feature of fisheries throughout Southeast Asia, providing livelihood and income opportunities for rural and coastal communities. Meanwhile, there is increasing attention to addressing the involvement of women and men and recognizing gender equitable, socially inclusive, and well-being-based approaches to the implementation of local-level activities in fisheries and habitat management, and livelihoods diversification to raise the profiles of women and other vulnerable groups by integrating gender perspectives in the fisheries sector. Gender equity and equality are one of the principles of FAO Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries (SSF Guidelines) in the Context of Food Security and Poverty Eradication (FAO, 2015).

For several years, SEAFDEC has been striving to mainstream and integrate gender within the organization as well as in its programs and projects. Several fisheries and aquaculture stakeholders from the SEAFDEC Member Countries benefited from the activities conducted by SEAFDEC in collaboration with partners that support the implementation of relevant instruments and frameworks on gender, particularly the SSF Guidelines RES&POA-2030, SEAFDEC Strategies, and SEAFDEC Gender Strategy (SEAFDEC, 2019). Since the early 2000s, SEAFDEC implemented numerous gender-responsive projects in different sites throughout the Southeast

Asian region with activities including training courses, studies, awareness-raising, and capacity-building, among others.

Integrated Coastal Resources Management

The project "Integrated Coastal Resources Management" was implemented by SEAFDEC with support from the Japanese Trust Fund during 2001–2010 in three sites, namely: Chumphon in Thailand, Langkawi in Malaysia, and Sihanoukville in Cambodia. The objective of the Project was to enhance fisheries resources and alleviate poverty in the Project sites where women and men were involved in livelihood to reduce over-dependence on coastal resources by encouraging and enhancing local businesses outside capture fisheries. The Project established the crab bank for blue swimming crabs in Thailand in 2005 and replicated it in the Project sites in Malaysia in 2007 and Cambodia in 2007.

Crab bank in Cambodia

Crab bank in Thailand

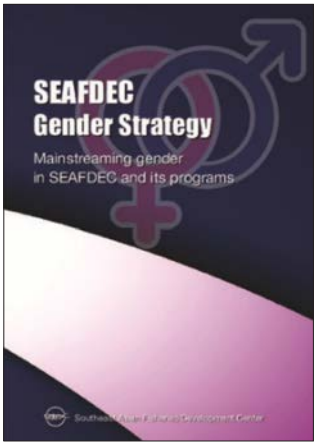
The crab bank was intended to enhance crab stocks and ensure the sustainable use of crab resources by allowing gravid female crabs to spawn before or instead of being sold for

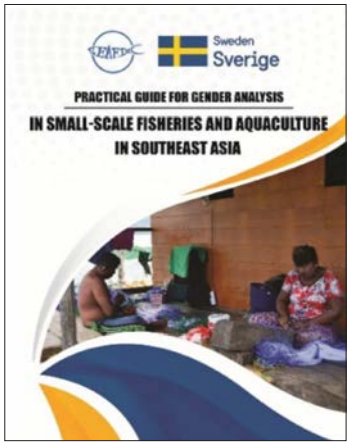
the rehabilitating of the coastal fishery resources and local livelihood security. The crab bank was an effective activity that inspired the local people to ensure that the crab resources were protected and conserved in a sustainable manner and enhanced the awareness of the women and men of the need to manage crab resources to improve their livelihoods. Women and men participate in crab bank activities depending on their expertise; for example, women cook for visitors and men provide technical information on crab bank.

Enhanced Fisheries Sector Capability for Sustainable and Socially Equitable Resources Management

The Sweden Embassy in Thailand supported SEAFDEC in implementing the project "Enhanced Fisheries Sector Capability for Sustainable and Socially Equitable Resources Management" which was also known as the SEAFDEC-Sweden Project from 2008 to 2019. The SEAFDEC-Sweden Project geographical focus areas included the Andaman Sea, Gulf of Thailand, Mekong River Basin, and Sulu Sulawesi Seas. The Project supported the ASEAN Member States (AMSs) in the implementation of activities at regional, sub-regional, and local levels to achieve sustainable use of aquatic resources and reduce vulnerability to climate change of coastal/rural (fishing) communities in the region. The focus of the Project was the strengthening of the capacity of AMSs to manage fisheries and habitats, manage fishing capacity, and combat IUU and destructive fishing. From 2015 to 2018, one of the activities under the Project was capacity building on gender for all staff from the SEAFDEC Secretariat and Departments including raising awareness of gender and how to conduct gender analysis.

Furthermore, the SEAFDEC-Sweden Project supported the development of the SEAFDEC Gender Strategy as well as the Practical Guide for Gender Analysis in Small-Scale Fisheries and Aquaculture in Southeast Asia (SEAFDEC, 2020a). The SEAFDEC Gender Strategy strives to mainstream and integrate gender perspectives into the SEAFDEC organization and in its programs, projects, and activities (SEAFDEC, 2019). The Strategies include 1) Mainstreaming genders at all levels of the organization, 2) integrating gender in SEAFDEC programs and projects, 3) incorporating gender perspectives in all events organized by SEAFDEC, 4) boosting the visibility of SEAFDEC as a gender-responsive and gender-sensitive organization, and 5) strengthening further the cooperation and collaboration with Member Countries and other organizations on gender aspects. Furthermore, the Practical Guide was developed through a series of regional consultations with the AMSs from 2017 to 2019 to support the AMSs





in integrating gender in their respective programs and projects to obtain sustainable fishery resources and eradicate poverty in small-scale fishing communities. Based on the framework of the SSF Guidelines, the Practical Guide includes the tools and procedures for gender analysis, guide questionnaires, gender-sensitive indicators, and data analysis.

Community-based Resources Management/ Co-management in Lao PDR

The project "Community-based Resources Management/Co-management in Lao PDR" with support from the Japanese Trust Fund was implemented by SEAFDEC in 2017–2019 in Nam Xouang Reservoir and Khammoune Province. In each Project site, the Fisheries Management Committee (FMC) was established to define the conservation zones, and fish processing groups were organized. The Project engaged women and men in activities where women were the main actors in local business while men were the leading actors in fishery resources enhancement.

Focusing on the fish processing groups in the Nam Xouang Reservoir, the group in Phonhong Village was composed of 10 women, and the group in Naxaithong Village had 12 women.

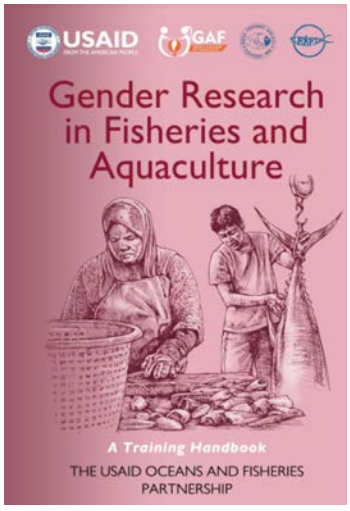
Members of the fish processing group in the Nam Xouang Reservoir, Lao PDR with the processed fish products they produced

The members of the fish processing groups underwent training in fish processing, marketing, and financial management to generate additional income. After obtaining knowledge and skills in fish processing, the women produced four products, *i.e.* wrapped sour fish (som hor), sour fish (som ton), sour fish eggs (som khai pa), and fermented fish (pa dek).

The Oceans and Fisheries Partnership (USAID Oceans)

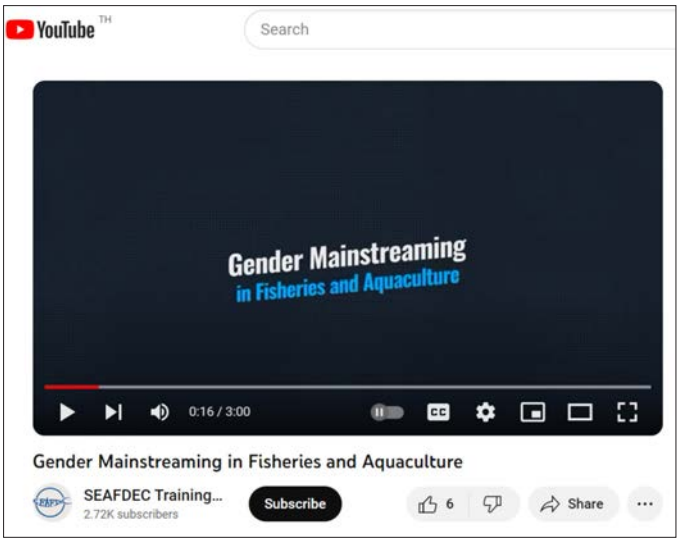
SEAFDEC has been working with the U.S. Agency for International Development (USAID) on the implementation of the project "The Oceans and Fisheries Partnership (USAID Oceans)" from 2015 to 2020. The aim of the USAID Oceans was to contribute to strengthening the Asia-Pacific region's capacity to combat illegal, unreported, and unregulated (IUU) fishing and seafood fraud, promote sustainable fisheries and conserve marine biodiversity in the region through a multi-pronged strategy that includes catch documentation and traceability, ecosystem approach to fisheries management (EAFM), human welfare and gender equality (HWGE), public-private partnerships, and communications and outreach.

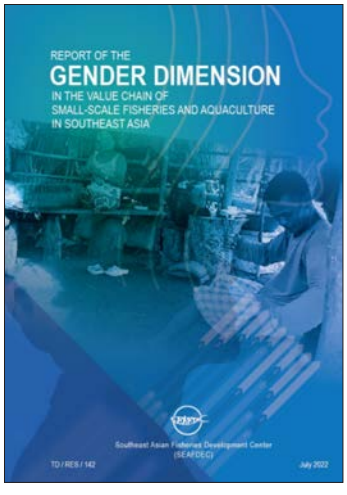
For HWGE, the activities include gender analysis in the learning site in Bitung, Indonesia in 2019 and General Santos, Philippines from 2016 to 2017 as well as training and workshops in the AMSs from 2015 to 2019. The Project produced several publications and videos including 1) Gender Research in Fisheries and Aquaculture: A Training Handbook, 2) Assessing Fisheries in a New Era: Extended Guidance for Rapid Appraisal of Fisheries Management Systems, 3) The Hidden Half: Women's Role in Southeast Asia's Fisheries (Part 1 and Part 2) (video), and 4) Regional Workshop on Gender Strategies Implementation (USAID, 2020). In Bitung, Indonesia, the ID cards of women fishers do not indicate their occupation as fishers; thus, the Project assisted the women in increasing their awareness of the importance of indicating their occupation in their ID cars so that they can avail of the incentives from the government (Satapornvanit & Parengkuan, 2020). In General Santos, Philippines, there were different gender roles between women and men; men were fishing at sea, hauling, loading, and unloading fish, while women worked on shore preparing for fishing trips, processing fish, and selling fish products. However, women's participation was limited in fisheries management even if they were involved in the fisheries value chain. Therefore, the Project conducted activities to build awareness of gender aspects of fisheries officers and the local community to promote gender equality (USAID Oceans, 2018).



Gender Dimension in the Value Chain of Small-scale Fisheries and Aquaculture in Southeast Asia

With support from the FAO, SEAFDEC implemented the project "Gender Dimension in the Value Chain of Small-scale Fisheries and Aquaculture in Southeast Asia" in 2020–2022. The Project aimed at improving and strengthening the gender dimension in selected sites in Southeast Asia, namely: Bolikhamxay Province, Lao PDR for inland capture fisheries; Kyauktan, Yangon Province, Myanmar for freshwater aquaculture; Infanta, Quezon, Philippines for marine capture fisheries, and Surat Thani Province, Thailand for mariculture. Under the Project, fisheries officers from the four Project sites were trained in gender analysis including data collection and analysis, while the local community learned gender concepts





during the validation workshops. The outputs of the Project include a brochure on the daily life of women and men in small-scale fisheries and aquaculture and a video on gender mainstreaming in fisheries. Furthermore, the project also developed the Training Module on Gender Mainstreaming in the Fisheries Sector which is composed of gender concepts and mainstreaming tools and was utilized in several capacity-building activities on gender organized by SEAFDEC.

Series of training workshops on gender for fisheries officers from the AMSs (from top to bottom: Indonesia, Malaysia, and Viet Nam, and Cambodia)

Small-scale Fisheries Management for Better Livelihood and Fisheries Resources

The project with the duration from 2020 to 2024 entitled "Small-scale Fisheries Management for Better Livelihood and Fisheries Resources" supported by the Japanese Trust Fund is being implemented by SEAFDEC for the sustainable management of small-scale fisheries to improve the livelihood and well-being of fishers in Southeast Asia. One of the components of the Project is gender integration and women empowerment in sustainable fisheries management in the AMSs where a series of regional and national training workshops on gender integration in small-scale fisheries were conducted for fisheries officers to enhance their knowledge of gender and apply it in their workplace in the respective AMSs. The Training Module on Gender Mainstreaming in the Fisheries Sector was utilized during the training courses conducted in Indonesia in September 2022, Malaysia in October 2022, Cambodia in March 2023, and Viet Nam in April 2023.

Regional Capacity Building Network (RECAB)

The regional capacity development program of SEAFDEC entitled "Regional Capacity Building Network (RECAB)" approved by the SEAFDEC Council in 2021 offers an intensive training course on a specific subject in fisheries and aquaculture to enhance the capacity of relevant fisheries officers from the AMSs. The first training course of the RECAB was the Regional Training Course on Gender Mainstreaming in Small-scale Fisheries and Aquaculture for Sustainable Development in Southeast Asia in 2022 in Thailand. The Training Module on Gender Mainstreaming in the Fisheries Sector was utilized during the Training which included lectures, discussions, individual and group assignments, quizzes, and field trips. The trainees include relevant fisheries officers from the AMSs, namely: Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Thailand, and Viet Nam as well as staff from the SEAFDEC

Regional Training Course on Gender Mainstreaming in Small-scale Fisheries and Aquaculture for Sustainable Development in Southeast Asia in 2022 in Thailand

Secretariat and Departments. The trainees developed an action plan for gender integration in their workplace and in developing gender-responsive fisheries programs and projects in their respective countries.

Visibility of SEAFDEC as a gender-responsive organization

In addition to collaborative partnerships with other organizations in implementing projects and conducting activities on gender in various events of other organizations (**Box 4**) by sharing expertise and experience from several gender-related projects and activities implemented in the past years.

Conclusion and Way Forward

SEAFDEC will continue to strive to mainstream and integrate gender in the small-scale fisheries of the countries in the Southeast Asian region. Gender analysis is widely recognized as a significant tool for identifying gender issues and developing gender-responsive projects to achieve gender equality and equity in small-scale fisheries. Therefore, one of the crucial activities that should be sustained by SEAFDEC is the capacity-building of the fisheries officers to enable them to conduct gender analysis in their respective countries.

Box 4. Gender-related events participated by SEAFDEC

- Women and Community-Based Coastal Resources Management in South East Asia" of KIARA (The People's Coalition for Fisheries Justice) in Jakarta, Indonesia on 29–30 December 2015
- "6th Global Symposium on Gender in Aquaculture and Fisheries (GAF6) with 11th Asian Fisheries and Aquaculture Forum" of Asian Fisheries Society on 3–7 August 2016 in Bangkok, Thailand on 3-7 August 2016
- "8th National Conference on Gender and Fisheries" of Women in Fisheries (WINFISH) in Iloilo City, Philippines on 28–30 September 2016
- "Expert workshop on Gender-equitable small-scale fisheries in the context of the implementation of SSF Guidelines of FAO" in Rome, Italy, on 28–30 November 2016
- "6th Marine Science Conference" of Burapha University in Chonburi, Thailand, on 18–20 June 2018
- "7th Global Symposium on Gender in Aquaculture and Fisheries" of GAF in Pathum Thani, Thailand on 18-21 October 2018
- "3rd World Small-Scale Fisheries Congress" of Too Big To Ignore (TBTI) in Chianng Mai, Thailand on 22–26 October 2018
- "12th Asian Fisheries and Aquaculture Forum" of Asian Fisheries Society, Iloilo, Philippines on 10-11 April 2019
- "Unpacking the SSF Guidelines: Mainstreaming gender for SSF development strategies" of FAO, Virtual Meeting on 3 June 2021
- "Women Leaders Forum" of Coral Triangle Initiative (CTI) Virtual Meeting on 8 October 2021
- "Webinar on Gender and Labor in Fisheries: Women Work in Fisheries, Too!" of USAID SUFIA and GAF, Virtual Meeting on 29 November 2021
- "Mainstreaming Agro-biodiversity for Sustainable food system in Southeast Asia: Indigenous Women of the ASEAN region as Custodians of Agrobiodiversity" of Mekong Institute, Virtual Meeting on 14–15 December 2021
- "4th World Small-Scale Fisheries Congress (4WSFC)" of Too Big To Ignore (TBTI) in Japan on 9–14 May 2022
- "Workshop on toward implementing small-scale fisheries guideline for gender equitable and climate resilient food systems and livelihoods" of FAO in Accra, Ghana on 6–9 June 2022
- "8th Global Conference on Gender in Aquaculture and Fisheries" of GAF in Kochi, India on 21-23 November 2022
- "Addressing Labor Exploitation in Fishing in ASEAN (ALFA) Project" in Indonesia on 28 November 2022
- "International Conference on Achieving Ocean Equity: Innovative, Fair, Inclusive and Sustainable Strategies and Blue Impact Investments" of ADBI in Australia from 27 February to 1 March 2023
- "Consultation workshop on participatory review and selection of adaptation options with inclusive, gender-responsive Multi-Criteria Analysis (MCA) to improve natural resource management" of UNDP in Phetchaburi Province on 15 May 2023
- "Consultation Workshop on Assessment and Prioritization of Climate Adaptation Measure in Coastal Communities" of UNDP in Songkhla, Thailand on 29 May 2023 and Surat Thani, Thailand on 31 May 2023

Moreover, SEAFDEC would continue to adhere to its Gender Strategy by mainstreaming gender at all levels of the organization, integrating gender in programs and projects, incorporating gender perspectives in all events, boosting the visibility of SEAFDEC as a gender-responsive and gender-sensitive organization, and strengthening further the cooperation and collaboration with Member Countries and other organizations.

Acknowledgments

The author extends gratitude to all funding sources of SEAFDEC projects on gender and activities on the promotion of gender equality and equity in the small-scale fisheries of the Southeast Asian region, namely: FAO, Japanese Trust Fund, Sweden Embassy in Thailand, and USAID. Sincere thanks are also given to all gender experts who served as resource persons in gender-related activities organized by SEAFDEC.

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About the Author

Ms. Jariya Sornkliang is a Fisheries Management Scientist at SEAFDEC Training Department in Samut Prakan Province, Thailand (Email: jariya@seafdec.org)

Understanding the Gender Roles in Small-scale Fisheries and Aquaculture in Southeast Asia

Jariya Sornkliang, Mildred S.Mercene-Buazon, Wilhelmina Pearl Guliman, Eakapal Rattanapun, Krissana Chanprang, Myatt Khin Mar, and *Dongdavanh Sibounthong*

Keywords: gender roles, gender equality, gender in fisheries, small-scale fisheries

The SEAFDEC Training Department implemented the project "Gender Dimension in the Value Chain of Small-scale Fisheries and Aquaculture in Southeast Asia" from 2020 to 2022 with support from the Food and Agriculture Organization of the United Nations (FAO). Under the Project, a series of gender analyses were conducted in selected Member Countries, namely: Philippines for marine capture fisheries, Thailand for mariculture, Myanmar for inland capture fisheries, and Lao PDR for inland aquaculture. The activity profile of the respondents in each study site was described which was categorized into reproductive, productive, and community involvement. It was found that women and men were both essential in the value chain of fisheries and aquaculture based on their knowledge, experiences, and time allocation.

Generally, in Southeast Asian societies, women's roles in fisheries are not well recognized and are usually overlooked or underrepresented in official documents and statistics. Documentation of women's contributions in each component of the value chain in small-scale fisheries and aquaculture continues to be a challenge because of the informal nature of their work. Thus, the Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication (SSF Guidelines) recommend that gender mainstreaming should be made an integral part of all small-scale fisheries development strategies, which should take into consideration the different cultural contexts and challenging practices that are discriminatory against women (FAO, 2015). In relevance with the Strategies of SEAFDEC Towards 2030, Strategy 5 indicates the importance of "Addressing cross-cutting issues, such as labor, gender, and climate change, where related to international fisheries" by giving "cognizance of the importance of small-scale fisheries, the welfare of labor in fisheries, safety at sea, and gender equality in the fisheries and aquaculture sector."

The SEAFDEC Gender Strategy adopted in 2019 aims to mainstream and integrate gender perspectives into the SEAFDEC organization, and in its programs, projects, and activities. One of the projects that promoted the SEAFDEC Gender Strategy was the "Gender Dimension in the Value Chain of Small-scale Fisheries and Aquaculture in Southeast Asia" of the Training Department of SEAFDEC implemented from 2020 to 2022 with support from the Food and Agriculture Organization of the United Nations (FAO). Under the Project, a series of gender analyses were conducted in particular fisheries sub-sectors in selected Member Countries, namely: Philippines for marine capture fisheries, Thailand for mariculture, Myanmar for inland capture fisheries, and Lao PDR for inland aquaculture (**Figure 1**). The data were collected from 2021 to 2022 through semi-structured interviews.

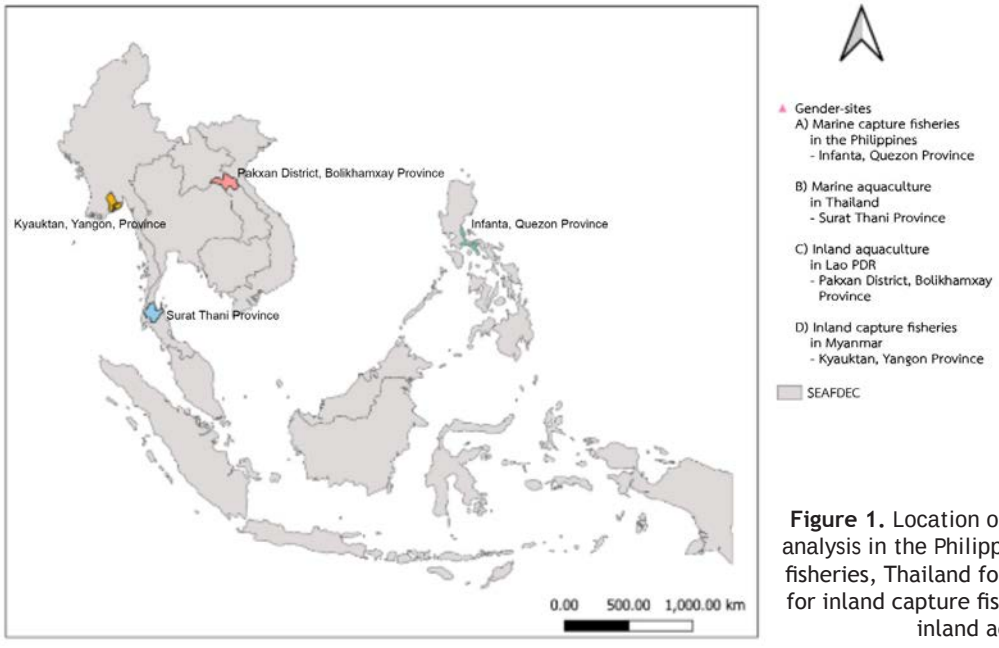

Figure 1. Location of study sites for gender analysis in the Philippines for marine capture fisheries, Thailand for mariculture, Myanmar for inland capture fisheries, and Lao PDR for inland aquaculture

The activity profile of the respondents in each study site was described following the Harvard Analytical Framework, which is categorized into reproductive, productive, and community involvement. Reproductive activity involves the care and maintenance of the household and its members, productive activity produces goods and services for home consumption and sale, and community work involves activities for the management and well-being of the community that are voluntary and unpaid (FAO, 2011).

Marine capture fisheries in the Philippines

In Infanta, Quezon, Philippines, the data collection (**Figure 2**) was conducted in November 2021–March 2022 with a total of 40 respondents including 18 females and 22 males. The respondents use hook and line (87 %), set nets (5%), gillnets (5%), and miscellaneous gears (3%). The species caught are skipjack tuna, yellowfin tuna, sardines, dolphin fish, herring, red snapper, threadfin bream, clown fish, goatfish, grouper, round scad, big-eye snapper, hardtail mackerel, Indian mackerel, bangus fry, milkfish, moon fish, among others.

Results of the survey indicated the local perspective that women work for light jobs and men for heavy jobs (**Figure 3**). Women work mainly as cleaners taking charge of washing clothes and dishes and cleaning the house, while men work for house maintenance as well as fishing and raising livestock for household consumption. Women and men work together in childcare, as well as caring for the elderly or sick family

Figure 2. Interview with the respondents in marine capture fisheries in Infanta, Quezon Province, Philippines

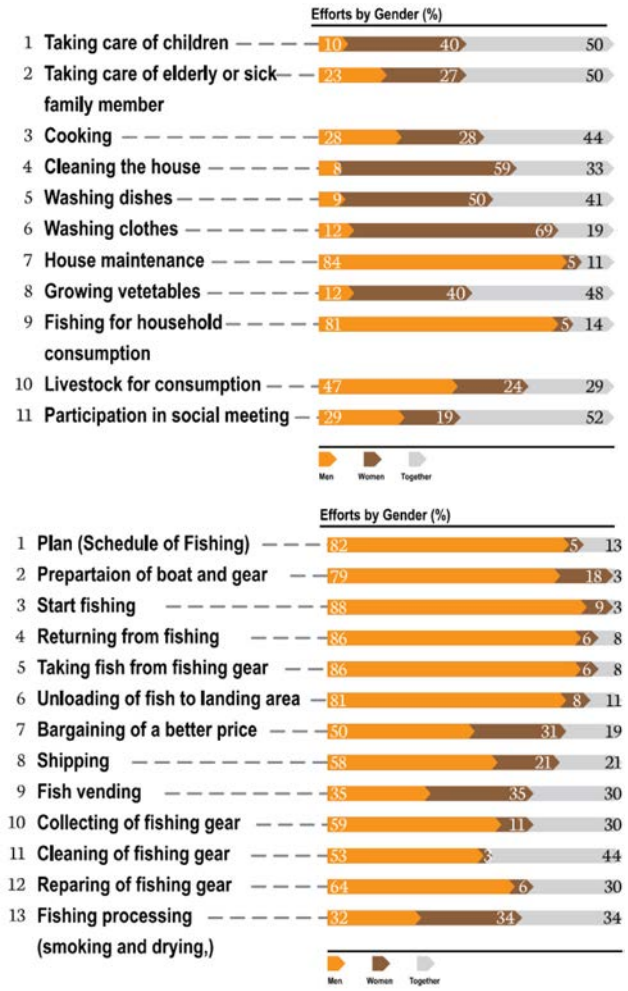

Figure 3. Reproductive *(top chart)* and productive *(above chart)* roles of women and men (n = 40) in marine capture fisheries in Infanta, Quezon Province, Philippines

members of the family, cooking, and participating in social activities. For productive roles, women and men work together in fish processing and fish vending. Other activities such as planning for fishing, preparing boats and gear, fishing, removing fish from gears, unloading fish to landing areas, bargaining for better prices, shipping, collecting the fishing gear, cleaning fishing gear, and repairing fishing gear are mainly done by men. However, the women also participate in most activities, especially in fish processing, fish vending, and shipping bargaining for better fish prices, and preparing boats and gear.

Mariculture in Thailand

In Surat Thani Province, Thailand, the data collection (**Figure 4**) was conducted in August–September 2022 with a total of 93 respondents, including 29 females and 64 males. The cultured species of the respondents include crab (51 %), fish (31 %), and shrimp (18 %).

Figure 4. Interview with the respondents in small-scale mariculture in Surat Thani, Thailand

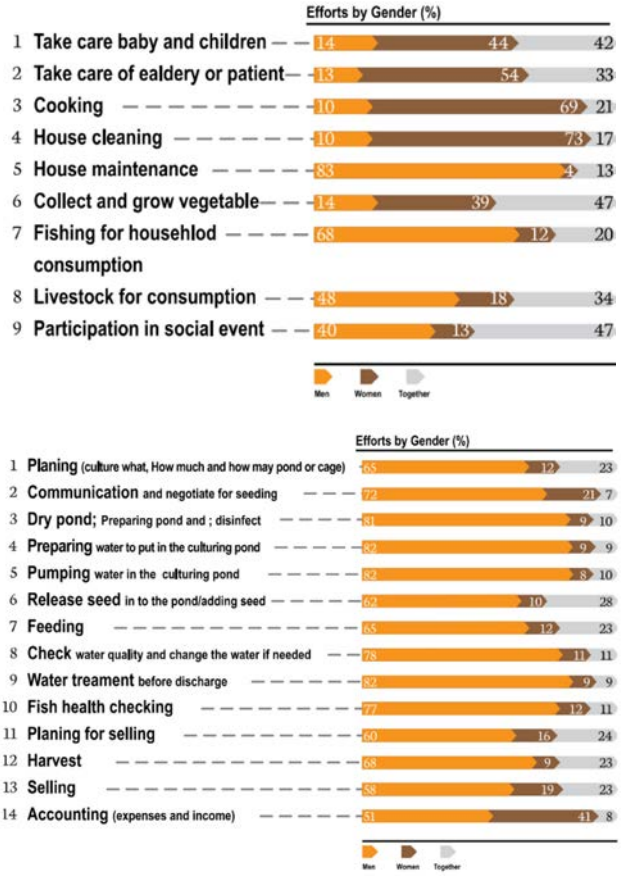

Figure 5. Reproductive *(top chart)* and productive *(above chart)* roles of women and men (n = 93) in mariculture in Surat Thani, Thailand

Although men may have their leading roles in aquaculture and the main role of women is in the household, both men and women could help together in the household chores and aquaculture operations (**Figure 5**). The gender roles in the household showed that women still do the housework such as cooking, taking care of children and the elderly, and backyard gardening. In contrast, men do laborious tasks such as house repair. Men prepare and arrange for the aquaculture operations, while women are also involved in some tasks such as helping to prepare the ponds, communicating with suppliers of fish seeds or fry, harvesting, selling, and accounting. Moreover, women had the same chance of attending community activities as men. For productive roles, men do most of the tasks in aquaculture while men and women share the burden of accounting for expenditures and income. Considering that men are more knowledgeable than women in aquaculture, men are overburdened because the activities usually involve heavy work meant for income generation. Meanwhile, women also take part in negotiations for seeds, planning for product sales, and selling of produce that only needs a little heavy work especially since women are already occupied by their reproductive roles.

Inland capture fisheries in Myanmar

In Kyauktan, there was a total of 40 respondents including 12 females and 28 males (**Figure 6**). All respondents use licensed fishery vessels with outboard motors and use drift nets in rivers. Their catch is multispecies composed mainly of

Figure 6. Interview with the respondents in inland capture fisheries in Kyauktan, Yangon Province, Myanmar in May–June 2021

threadfin (*Polynemus* sp.), catfish (*Arius* sp.), croaker (*Johnius* sp.), hilsa (*Tenualosa ilisha*), and basa fish (*Pangasius* sp.).

For reproductive roles, the women perform the tasks of taking care of elderly or sick family members, cooking, and cleaning the house (**Figure 7**). Women and men together to take care of children, do house maintenance, grow vegetables, raise livestock for consumption, and participate in social meetings. Men have no dominant work for reproductive roles. For the productive roles, men work to prepare and arrange for the fishing operations, decide on the species of fish to be captured or the fishing gear to be used, check the boat engine before going to fish, check gear and all equipment needed before they go fishing, drive or steer the boat to the fishing ground, set out the fishing gear, and bring fishing gear and boat or engine for maintenance. Meanwhile, the women assist men in the maintenance of fishing gear and nets and repair fishing gear if necessary. Women also help the men by checking the weather and tide which could support information for decision making to go fishing. Furthermore, women produce fish paste and help the men dry fish. Men have more roles in fisheries post-harvest than women, *e.g.* chilling fish with ice, sorting fish by species, size, and weight, drying fish, and selling fresh fish.

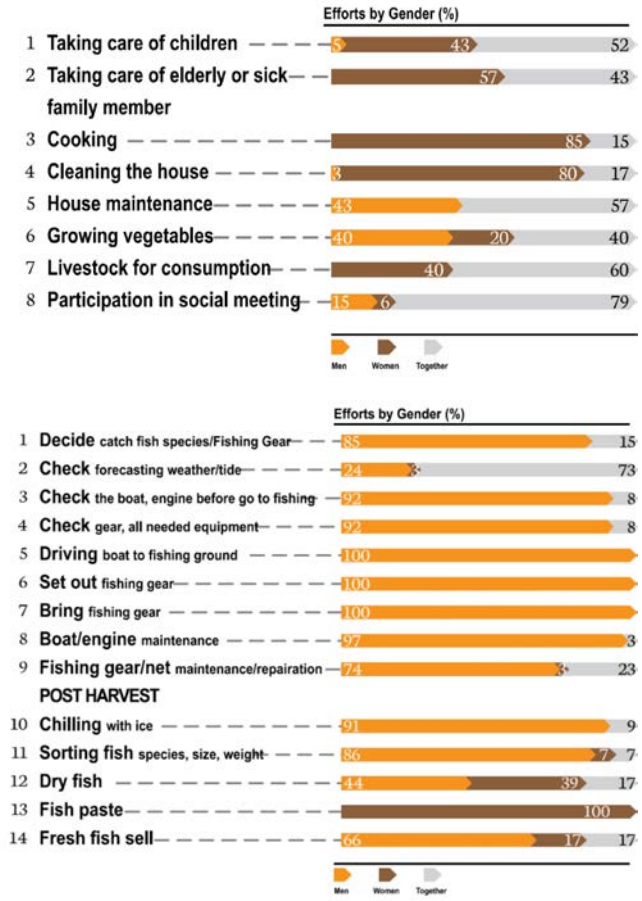

Figure 7. Reproductive *(top chart)* and productive *(above chart)* roles of women and men (n = 40) in inland capture fisheries in Kyauktan, Yangon Region, Myanmar

Inland aquaculture in Lao PDR

In Pakxan District, Bolikhamxay Province in Lao PDR, the data collection (**Figure 8**) was conducted in January–March 2021 with 28 respondents (8 females, 20 males). Among the respondents, 96 % engaged in small-scale inland aquaculture. The two main freshwater cultured fish species are tilapia (53 %) and catfish (47 %).

Figure 8. Interview with the respondents in small-scale inland aquaculture in Pakxan District, Bolikhamxay Province, Lao PDR

Figure 9 shows that the role of men and women is divided physically regarding sex. Men perform productive roles while women focus on reproductive roles because they believe that women are skillful in caring for their families and that men must work hard for their families. Nonetheless, looking carefully at the reproductive roles, women perform their work daily while men work only occasionally. The daily chores of women make them busy and occupied to the extent that they have no time to attend village meetings. Women only participate a little in aquaculture activities because men are well known to be adept in aquaculture operations while women are busy doing household chores. Nonetheless, women also do their job of helping the male members of the family to be successful in their aquaculture endeavors. Furthermore, the male respondents indicated that they do not perform household chores revealing a strong stereotype that women work for household needs while men work for income.

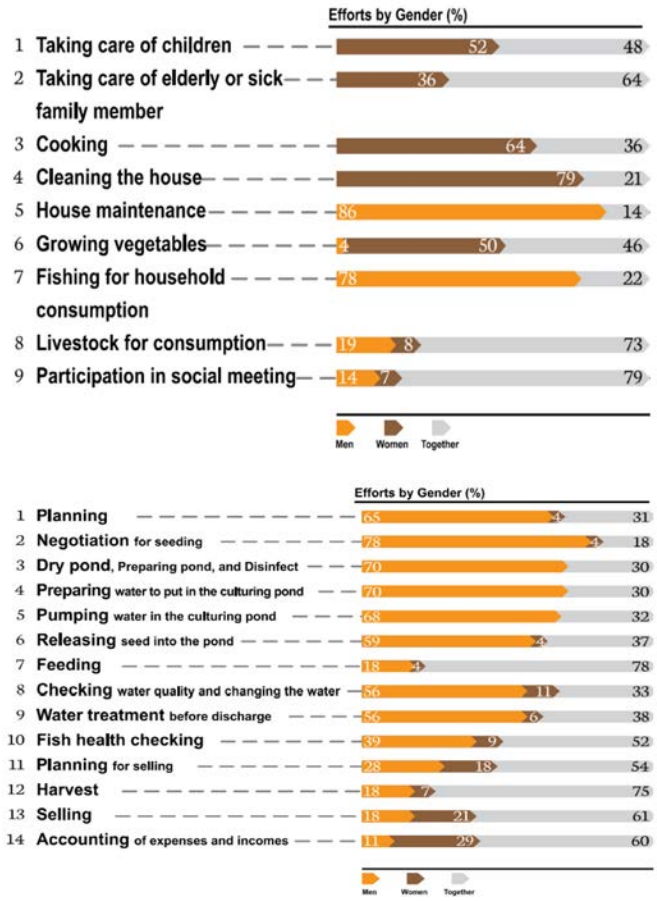

Figure 9. Reproductive *(top chart)* and productive *(above chart)* roles of women and men (n = 28) in inland aquaculture in Pakxan District, Bolikhamxay Province, Lao PDR

Conclusion and Recommendations

This study revealed that the female and male respondents were involved in almost all processes of fishing and aquaculture. Nevertheless, the gender-differentiated roles were based on a solid stereotype of gender division of labor that men must work for complex and heavy tasks in productive roles. In contrast, women work for household chores and not-so-heavy tasks in productive roles. The study emphasized that women and men are both essential in the value chain of fisheries and aquaculture based on their knowledge, experiences, and time allocation. Therefore, to approach gender equality, the capability of stakeholders should be enhanced through education and communication to empower the women and men in the community based on their needs and the opportunities for their viable livelihoods. The study suggests that men and women should have more understanding of the gender roles that can change their attitude on working, which is to assist each other in the household work because, in terms of work time spent, women have more workload than men. Capacity building in relevant areas is crucial to empower men and women in small-scale fishing and aquaculture to sustain their livelihoods.

Acknowledgments

The authors acknowledge the fishers and fish farmers for providing information during the survey. Thanks to all enumerators from the Philippine Bureau of Fisheries and Aquaculture Resources, Department of Fisheries of Thailand, Department of Fisheries of Myanmar, Department of Livestock and Fisheries of Lao PDR, and SEAFDEC/TD. Lastly, the authors would like to thank the Food and Agriculture Organization of the United Nations (FAO) for supporting the project "Gender Dimension in the Value Chain of Small-scale Fisheries and Aquaculture in Southeast Asia."

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About the Authors

Ms. Jariya Sornkliang is a Fisheries Management Scientist at SEAFDEC/TD in Samut Prakan Province, Thailand (Email: jariya@seafdec.org)

Ms. Mildred S.Mercene-Buazon is the Chief Administrative Division of the Bureau of Fisheries and Aquatic Resources, Department of Agriculture, Philippines (Email: mmbuazon@gmail.com)

Ms. Wilhelmina Pearl Guliman is the Chief of the Property Section of Bureau of Fisheries and Aquatic Resources, Department of Agriculture, Philippines (Email: minaguliman@gmail.com)

Mr. Eakapal Rattanapun is a Fishery Biologist from the Department of Fisheries, Thailand (Email: kug.eakapal@gmail.com)

Mr. Krissana Chanprang is a Fishery Biologist from the Department of Fisheries, Thailand (Email: chunprang_4584@hotmail.com)

Ms. Myatt Khin Mar is the Deputy Director and Section Head of the Water Quality Control and Freshwater Research Center and Crocodile Farm of the Department of Fisheries, Myanmar (Email: mar268354@gmail.com)

Ms. Dongdavanh Sibounthong is the Administrative Division Deputy Head and Gender Focal Person from the Department of Livestock and Fisheries, Lao PDR (Email: apone53@gmail.com)

Promoting CBRM and co-management: empowering women in fish processing group in the Nam Xouang Reservoir, Lao PDR

Rattana Tiaye, Thanyalak Suasi, and *Jariya Sornkliang*

Keywords: CBRM, co-management, small-scale fisheries, fish processing, women empowerment, gender in fisheries

Community-based resources management (CBRM) is a strategy for coastal fisheries resources management with the participation of people in natural resource and environment management (Macfadyen, 2005). CBRM is a form of co-management where responsibility and authority for resource management are shared between the government and local resource users/community (Pomeroy, 1995). Moreover, co-management is a partnership approach where government and resource users share the responsibility and authority for managing a fishery or area (Macfadyen, 2005). Relying on the effectiveness of these management strategies, the SEAFDEC/Training Department (SEAFDEC/TD) implemented the project "Facilitating Fisheries Activities Information Gathering Through Introduction of Community-based Resources Management/Co-management" between 2017 and 2019 with support from the Japanese Trust Fund. The Project was aimed at improving the fishery resources management and livelihood of local people which was aligned with the SEAFDEC Strategy 1 "*Securing the sustainability of fisheries to contribute to food security, poverty alleviation and livelihood of people in the region*."

The main activities at the Project pilot site in Nam Xouang Reservoir in Phone Hong District, Lao PDR include 1) establishment of the Fishery Management Committee (FMC), 2) promotion of fishery rules and regulations, 3) strengthening of fishery resources management, and 4) improvement of fish processing techniques. This article highlights the outcomes of the fourth Project activity that supports the Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2030 *No. 70 Strengthen support for the development and application of technologies and best practices that optimize the utilization of catches/farmed products, reduce post-harvest losses and wastes, value-add byproducts and valorize fish waste/trimmings in commercial and small-scale fisheries, aquaculture, and processing operations, through improved processing, facilities and infrastructure development, onboard and onshore handling, and storage, distribution and marketing of fish and fishery products* (SEAFDEC, 2020) to pave the way for women's participation and decision-making.

In small-scale fishery, particularly inland fisheries, women are involved in both pre-harvesting and post-harvesting tasks such as preparing food for the fishers (their husbands), weaving nets, selling fish, processing fish, marketing fish, and keeping accounts, while the main role of men is harvesting fish (WWF-UK, 2012). Besides, women in Asia are the key persons in the trade of fish and fishery products in 5,000–6,000 fish markets throughout the lower Mekong basin (Monfort, 2015). Although it is widely accepted that women perform important roles in the fishery value chain, they are still inadequate in capacity such as adding value to fishery products, and have low participation in decision-making in other fishery activities such as being involved in fishery groups and fishery management. Besides, women often have unequal power to access innovative technology, finance, and services in the value chain (FAO, 2020).

The women need support for job opportunities, specifically in fish processing products. It is important to increase their capacity to improve their skills in fish processing and the quality of their products for better market access (USAID, 2018). Zelasney, *et al*. (2021) inferred that women empowerment is the process of enhancing women's ability to determine their own choices, and their rights and their ability to organize, influence, and participate in change through decision-making for themselves and others. This may be done through training and education, and facilitating access to usable assets, technology, finance, and services.

Nam Xouang Reservoir

The Project pilot site was in Nam Xouang Reservoir located between Phone Hong District and Naxaythong District (**Figure 1**). The reservoir has a 4.5 km length, 9.0 km width, an area of 12.4 km^2, and 255.5 million m^3 water storage capacity, and it is used for irrigation, particularly for the rice paddy field. It is abundant in Nile tilapia and Chitala and the main fishing gear types used are gillnets, cast nets, scoop nets, and hooks.

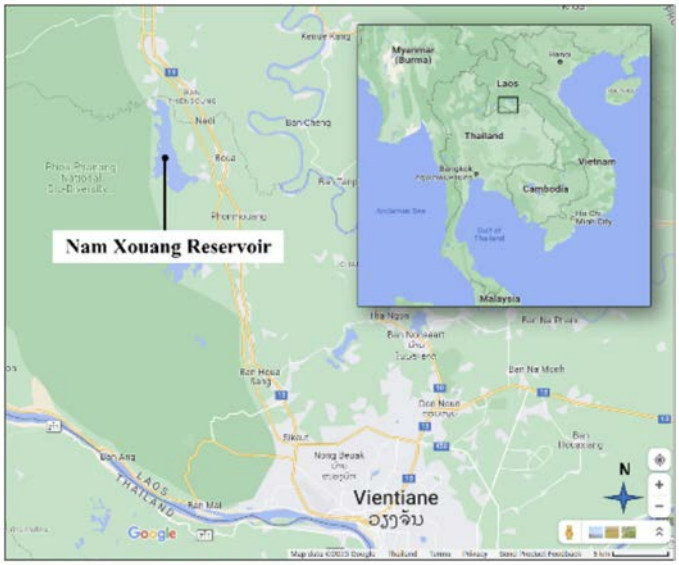

Figure 1. Location of Nam Xouang Reservoir in Lao PDR

The Fishery Management Committee (FMC) in the Nam Xouang Reservoir was established in 2017 in collaboration with the Department of Livestock and Fisheries (DLF) of Lao PDR and SEAFDEC/TD. The FMC developed the fishery management rules, conservation areas, and seasonal closure. Moreover, the women members have been encouraged and become actively involved in the activities including participation in the meetings, data collection, and contribution of ideas and recommendations on appropriate management measures. In 2019, the Project conducted a survey in the three of ten villages of Phone Hong District with 1,056 households including 142 fishing households as well as in all five villages of Naxaythong District including 1,202 households including 79 fishing households. It was found that the people living around the reservoir are mainly engaged in fish processing, livestock raising, labor, agriculture, and fishing. Moreover, the issues and problems related to fishery resources, governance, and human well-being were identified as listed in the **Table**.

Table. Issues and problems related to fishery resources, governance, and human well-being in the Nam Xouang Reservoir, Lao PDR

	Issues and problems
Fishery resources	• Decreasing fishery resources because of illegal fishing • Unclear conservation areas and fishing seasons for preserving aquatic resources and habitats
Governance	• Weak enforcement of fishery management measures • Absence of fishery management groups • Low participation and decision-making of women in social groups because they do not have enough confidence, knowledge, and ability
Human well-being	• Difficult transportation access to the capital, Vientiane, for job opportunities • Increasing number of fishers because of few job opportunities • Fewer job opportunities for the local people especially for women • Women have low income due to low capacity and skills, inadequate capital, and lack of technologies to improve processed fish products

Establishing the fish processing group

The women in the Nam Xouang Reservoir in Phone Phong District had long been producing processed fish products for household consumption and sold the excess products in the neighborhood. They wanted to have additional income from fish processing but had limited skills and knowledge of doing business and improving their products. With guidance from SEAFDEC/TD and DLF, the women established the fish processing group with 12 members including 10 women and 2 men in 2019 (**Figure 2**). The group members agreed on the rules and responsibilities of the members such as preparing materials, cleaning fish, filleting fish, selling, and accounting.

Figure 2. Meeting of the members of the fish processing group in Nam Xouang Reservoir in Phone Phong District, Lao PDR

The group members then indicated that their products could be sold in the neighboring villages, local markets, and nearby canteen for soldiers.

Capacity building

In order to enhance their skills in fish processing, the group members went on a study trip in Vang Vieng District in 2019 and trained in fish processing from preparing ingredients to packaging (**Figure 3**) and learned how to process the

Figure 3. Study trip and training of members of the fish processing group in Vang Vieng District, Lao PDR

Figure 4. Traditional processed fish products of Lao PDR (*top row:* fermented sour fish wrapped in banana leaves, fermented ground fish, fermented sour fish; *bottom row:* fermented fish dip, dried fish, fermented salted fish)

traditional processed fish products of the country (**Figure 4**). Some of the group members never had the chance to go outside their community for training; thus; it was deemed a good opportunity for them to gain knowledge, learn new skills, and share ideas.

Starting up the business

To start the business of the fish processing group, SEAFDEC/TD provided support with a budget of USD 330 for capital as well as materials (fish and ingredients) and equipment (blender, knives, chopping blocks). Applying the knowledge and skills they obtained from the study trip and training, the group members agreed to produce the products that have a high market demand in the Nam Xouang Reservoir, namely: fermented sour fish wrapped in banana leaves, fermented fish dip, dried fish, and fermented salted fish. The group members discussed the procedures and schedules for fish processing and decided to use the courtyard of the group leader's house for fish processing because of its large area. They planned to work at least two times per week and would depend on the availability of raw materials and orders from customers.

For the first round of production, they distributed their processed fish products for free to their neighbors for feedback. Subsequently, the customers liked the taste of their products, especially the fermented sour fish wrapped in banana leaves which was ordered the most. They sold their products first in the village and canteen for soldiers and after a month, they got orders from outside of their village. Besides, they could sell the fermented sour fish wrapped in banana leaves in the Vientiane morning market which is the big market in the capital. They gained a profit of about USD 61 after four rounds of production in 2019.

Thriving business

In 2022, SEAFDEC/TD followed up with the progress of the fish processing group and found that their business went well and they produced two additional products, namely: fermented sour fish wrapped in banana leaves and fermented salted fish (**Figure 5**). They sold their products daily and directly in the markets wholesale and retail. For every production cycle, the production cost of fermented sour fish wrapped in banana leaves, which is the main product, was LAK 600,000 (USD 31) with the selling price of LAK 1,820,000 (USD 93). Their estimated profit per month was LAK 1,720,000 (USD 99) where 95 % was distributed among the group members and the rest was allotted for the group's operation. The group members could now gain additional income which made them feel more confident to continue the fish processing business and planned to produce more types of products. The strong leadership of the head of the fish processing group and the commitment of local fisheries officers were crucial to the success of the group.

Figure 5. Members of the fish processing group in the Nam Xouang Reservoir in Phone Phong District, Lao PDR in 2022 earn higher income from the processed fish products they produced

Nonetheless, microfinance and credit services would be needed by the group to purchase the equipment to improve their products such as grinder machines and vacuum sealers to enhance their products in terms of packaging and sanitation to obtain certification standards. The group also needs to expand the market of their products including other marketplaces and platforms. The group members would welcome and appreciate study visits by other groups to exchange experiences and learn more techniques to produce new products.

Conclusion and Way forward

CBRM and co-management are considered effective ways for sustainable fisheries management where the government and the fisheries community are working together. Moreover, gender also should be considered and integrated into the implementation of policies or projects at all levels to ensure that women have equal access to the fisheries value chain. The Project successfully engaged and empowered the women at the pilot site in the Nam Xouang Reservoir who now have enhanced their knowledge and skills in fish processing and earn higher incomes. The following are the recommendations that should be considered in sustaining the activities of CBRM and co-management as well as of the fish processing group at the Project pilot site. At the same time, the applicability of these recommendations in other fisheries communities should be also considered.

- Promote CBRM and co-management by establishing community groups such as Fisheries Management Committee (FMC) and fish processing group specifying the rules and duties of the members
- Conduct gender analysis to identify the issues and opportunities for women's empowerment
- Increase the capacity and knowledge of the members of the fish processing group through study trips and training
- Provide funding support to start and sustain the business of the fish processing group
- Explore various marketing channels (*e.g.* online platforms, special markets, etc.) to sustain the business
- Conduct regular monitoring and evaluation to improve or maintain the activities of the fish processing group

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About the Authors

Ms. Rattana Tiaye is a Fisheries Management Scientist at SEAFDEC Training Department, Samut Prakan, Thailand. She was a technical staff of the project "Facilitating Fisheries Activities Information Gathering Through Introduction of Community-based Resources Management/Co-management." Email: rattana@seafdec.org

Ms. Thanyalak Suasi is the Fisheries Management Section Head at SEAFDEC Training Department, Samut Prakan, Thailand. She was a technical staff of the project "Facilitating Fisheries Activities Information Gathering Through Introduction of Community-based Resources Management/Co-management." Email: thanyalak@seafdec.org

Ms. Jariya Sornkliang is Fisheries Management Scientist and Gender Focal Person from the SEAFDEC Training Department, Samut Prakan, Thailand. She was a technical staff of the project "Facilitating Fisheries Activities Information Gathering Through Introduction of Community-based Resources Management/Co-management." Email: jariya@seafdec.org

Enhancing the Access of Small-scale Fishers to Financial Services: the case of Ban Hat Sai Khao Village in Ranong Province, Thailand

Thanyalak Suasi, Rattana Tiaye, and *Jariya Sornkliang*

Keywords: small-scale fisheries, financial access, fisheries socioeconomic

Based on the Royal Ordinance on Fisheries B.E. 2558 (2015) of Thailand, artisanal (small-scale) marine capture fishery refers to a fishing operation in the coastal zone within 3 nm from the shore using fishing vessels less than 10 GT while commercial-scale marine capture fishery uses fishing vessels from 10 GT fitted with engines. To support small-scale and commercial-scale fishers, the government established several financial assistance policies and programs. In 2020, the Loan Project was launched by the government to enhance the liquidity of the small-scale and commercial fishers affected by the measures to combat IUU fishing by providing funds for the improvement of fishing vessels and gear. The loan was provided through the Bank for Agriculture and Agricultural Cooperatives (BAAC) to the owners of small-scale and commercial-scale fishing vessels of less than 60 GT with a maximum loan amount of THB 5 million (USD 147,000) per person with collateral including fishing vessel, land/land with building, or joint liability group as a guarantee. The loan has to be paid back within seven years with an interest rate of 7 % wherein 4 % will be paid by fishers/borrowers and 3% will be supported by the government. During the COVID-19 pandemic, the small-scale fishers in Thailand obtained financial support from the government to sustain their livelihood and liquidity. To mitigate the impacts of the COVID-19 pandemic, the Ministry of Agriculture and Cooperatives provided financial assistance in the amount of THB 5,000 (USD 147) per month from April to June 2020 for the registered small-scale fishers and farmers. In addition, the insurance for small-scale fishers in Thailand is composed of two types, namely: 1) insurance policy in capture fisheries for the fishers who own a fishing vessel of less than 10 GT registered with the Marine Department and 2) voluntary fishers insurance policy (micro-insurance) covering small-scale and commercial fishing vessels. Both types of insurance policies aid fishers in alleviating the damage to fishing vessels and injury or death of fishers from natural disasters. However, the fishers lack the motivation to apply for micro-insurance because they could receive aid from the government and relevant agencies when needed (Nartaya, 2022).

Small-scale fisheries (SSF) provide fish for direct consumption in local communities and generate incomes to support local and national economies. Many small-scale fishing communities contribute to food security and nutrition, poverty eradication, equitable development, and sustainable resource utilization. However, small-scale fishing communities are commonly located in remote areas, earn low incomes, and tend to have limited access to markets as well as to health, education, and other social services (FAO, 2015).

The FAO Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication (SSF Guidelines) underline the importance of access to financial services for small-scale fisheries communities for their socioeconomic well-being such as housing, education, health, and fish production (Gietzen *et al*., 2023). Moreover, the ASEAN-SEAFDEC Plan of Action (POA) on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2030 (SEAFDEC, 2020) also considers the importance of financial incentives for small-scale fisheries, as indicated in POA No. 17 on 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 optimize economic returns*."

In the countries of the Southeast Asian region, financial services are recognized as important incentives for small-scale fishers and fish farmers for sustainable fishing and farming practices and activities. In support of the relevant international frameworks, the SEAFDEC Training Department implemented the project "Small-scale Fisheries Management for Better Livelihood and Fisheries Resources" in 2020–2024 with support from the Japanese Trust Fund. The aim of the Project is to achieve sustainable management of small-scale fisheries to improve the livelihood and well-being of fishers in Southeast Asia focusing on socioeconomic assistance, particularly microfinance, credit, and insurance in line with the implementation of the SSF Guidelines in Southeast Asia.

Socioeconomic Status of Small-scale Fishers

In 2020, the Project conducted a socioeconomic survey at the pilot learning site in Ranong Province, Thailand to understand the access of small-scale fishers to financial services, particularly credit and insurance. The socioeconomic survey was conducted in Ban Hat Sai Khao Village in Kampuan Sub-District, Suk Samran District, Ranong Province, Thailand located in southern Thailand on the east coast of the Andaman Sea (**Figure 1**) where approximately 234 families are mainly engaged in fisheries and agriculture. The purposive sampling method was applied by selecting target respondents from the Village who owned fishing vessels of less than 10 GT and

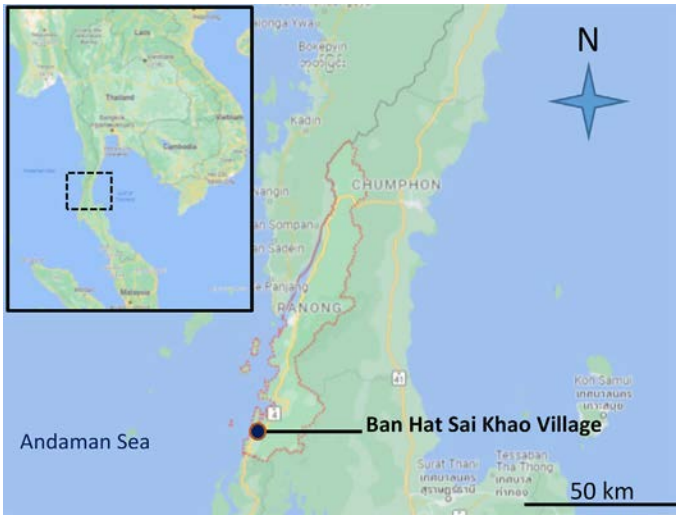

Figure 1. Location of Ban Hat Sai Khao Village in Ranong Province, Thailand *(Source: Google Maps)*

engaged in small-scale fisheries in nearshore waters. A total of 42 respondents (12 females and 30 males) were interviewed face-to-face using a questionnaire that was developed based on the framework of the SSF Guidelines.

The interviewed fishers were 25-78 years old and had an average age of 49 years old. As shown in **Figure 2**, 14 % were 25–35 years which can be inferred that the young generation may not be interested in fishing when their parents provided them with education and had the chance to choose other jobs. On the other hand, 22 % were 36–45 years old and more than one-third were 46–55 years old indicating that they engaged in small-scale fishing as their original occupation which they inherited from their parents, and they cannot change to the other jobs because they do not have qualifications and experience. Furthermore, 14 % were 56–65 years old and 12 % were > 65 years old, implying the aging of small-scale fishers and that fishing activities will be done by older fishers in the future. Therefore, the new generation should be encouraged to be involved in the fisheries sector as well as gear innovations should be developed to support fishing operations.

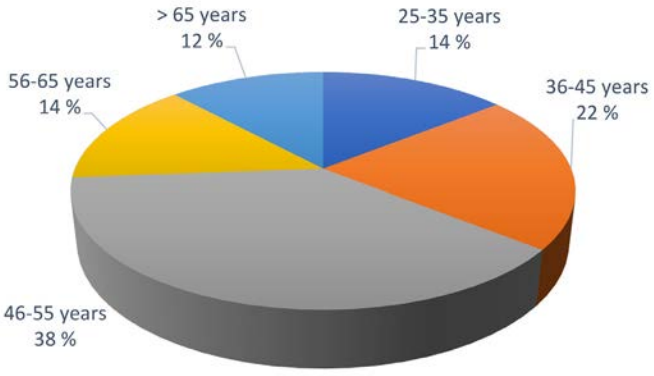

Figure 2. Age of interviewed fishers in Ban Hat Sai Khao Village (n = 42)

Although only 2 % had no education, primary school was the highest education level of almost three-quarters of the interviewed fishers (**Figure 3**) who were able to read and write as basic skills for loan application. In terms of occupation (**Figure 4**), 74 % of the interviewed fishers were earning an average monthly income of THB 11,145 (USD 328) from full-time fishing while the rest were engaged in fishery combined with other occupations such as trade and labor with an additional average monthly income of THB 7,000 (USD 196).

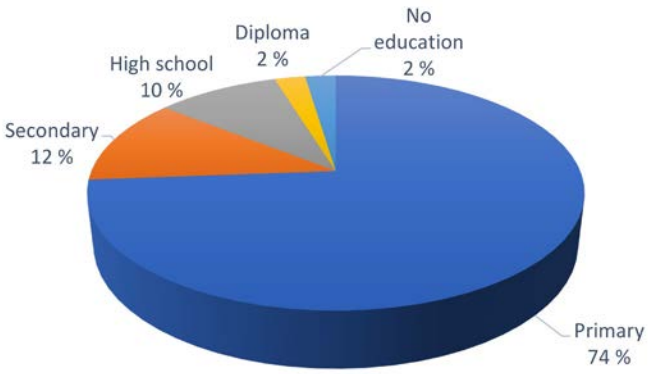

Figure 3. Education levels of interviewed fishers in Ban Hat Sai Khao Village (n = 42)

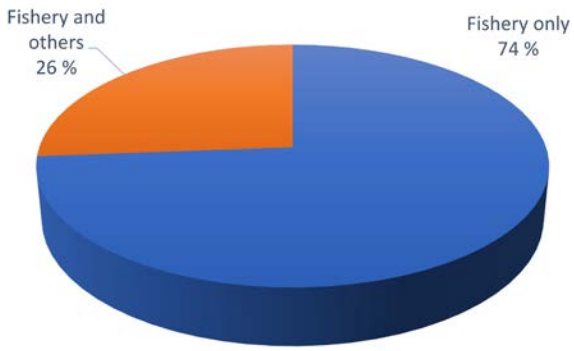

Figure 4. Occupation of interviewed fishers in Ban Hat Sai Khao Village (n = 42)

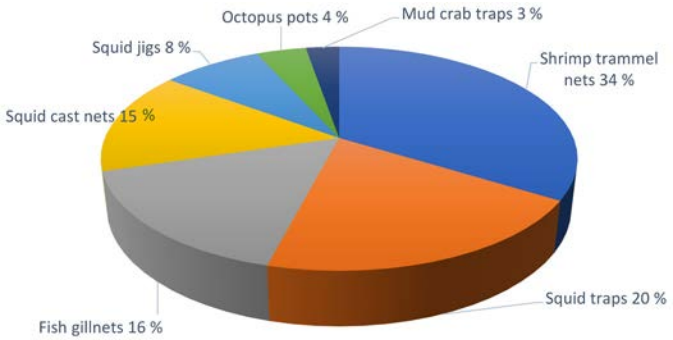

Figure 5. Types of fishing gear used by interviewed fishers in Ban Hat Sai Khao Village (n = 42)

The average fishing experience of the interviewed fishers was 27 years. All of them have their own fishing vessels made of wood with a length ranging from 4 m to 13 m which are mostly equipped with outboard engines (62 %) and inboard engines (38 %). The interviewed fishers owned more than one type of fishing gear and used the fishing gear type depending on the season of the target species. The types of fishing gear they use include shrimp trammel nets, squid traps, fish gillnets, squid cast nets, squid jigs, octopus pots, and mud crab traps (**Figure 5**).

Access to Financial Services

Credit

Financial services in Thailand such as for credit, savings, insurance, and others are offered by financial institutions which are divided into three groups (*i.e.* formal, semi-formal, and informal) which are based on their legal status and level of supervision. Formal financial institutions refer to mainstream financial institutions with a clear legal status that obtains licenses granted under relevant business laws or initially established by a specific constitutional law (*e.g.* commercial banks, specialized financial institutions, finance companies). Semi-formal financial institutions refer to institutions whose legal status is granted by specific laws and supervised or examined by other government authorities (*e.g.* cooperatives, credit unions, savings groups for production, village funds). Informal financial providers (generally not referred to as institutions) refer to individuals or juristic providers with no legal status under any business or law and are not supervised or examined by government authorities (*e.g.* savings groups, self-help groups, community-based financial institutions, money lenders) (Bank of Thailand, 2020; Ledgerwood, 1998).

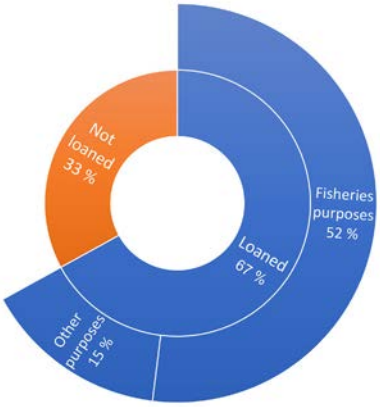

Figure 6. Proportion of interviewed fishers in Ban Hat Sai Khao Village who availed of credit services (n = 42)

Most interviewed fishers (67 %) took loans from financial service providers with more than half of them used the loan for fisheries purposes including investment in fishing vessels, fishing gear, and fishing operation costs, while the rest used the loan for other purposes such as child education, trade investment, and personal expenses. Moreover, 33 % of the interviewed fishers did not take any loans as they could use their own savings (**Figure 6**). The information on financial services could be accessed through community meetings, village radio broadcasts, friends, and other channels such as social media and relatives. Also, the interviewed fishers can obtain information directly from the bank through a telephone call, letter, and personnel contact.

The interviewed fishers borrowed money from the Village Fund (42 %), Bank of Agriculture and Agricultural Cooperatives (BAAC) (36 %), middle persons (13 %), and other sources such as neighbors and USAID (9 %) (**Figure 7**). The Village Fund is the basic source of credit in the local community and a semi-formal financial institution that was established in 2001 as a government policy in every village across Thailand by allocating THB 1 million to the village for soft loans with low interest for the local people to improve

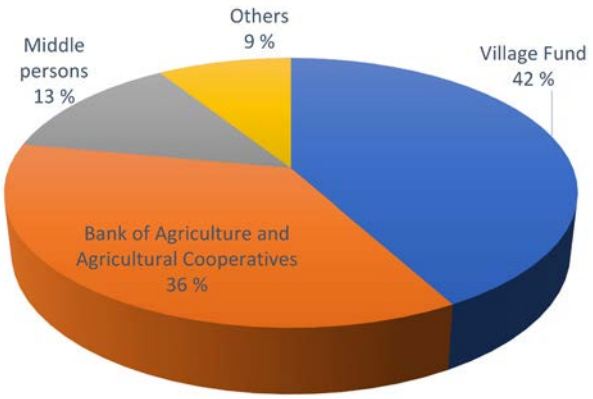

Figure 7. Sources of credit services availed of by interviewed fishers in Ban Hat Sai Khao Village (n = 42)

their livelihoods and occupation. BAAC is a formal financial institution and specialized financial service provider to agriculture and its sub-sector including fisheries owned by the government and plays an important role in supporting and implementing government policies. The middle persons are the informal financial providers who lend money to fishers through a patronage system wherein fishers borrow money from middle persons to fund fishing operations and fishers sell their catch to the middle person and pay their debt. USAID implemented a special microfinance program since 2005 that supported villages after the tsunami disaster in Thailand in 2004.

Those who loaned from BAAC had the ability to prepare the document and use an asset (*i.e.* fishing vessel) as collateral or group with other fishers as personnel collateral. On the other hand, the interviewed fishers who do not know the process of getting a loan from BAAC opted to access loans from informal financial providers. In accessing financial services from formal, semi-formal, and informal institutions, financial service providers should provide comprehensive information on loan programs to assist small-scale fishers to avail of credit efficiently.

Insurance

About 69 % of interviewed fishers realized the risks in their lives so they applied voluntarily for insurance for health, life, and fishing vessels from private insurance companies. The government should cooperate with private insurance companies to develop the appropriate insurance program to support small-scale fishers that also ensure the access of women.

Although the rest of the interviewed fishers did not apply for insurance, they could benefit from the Universal Coverage Scheme (UCS) and other social welfare schemes for government officers and the elderly. Since they have low income and have no health protection in the informal sector, the small-scale fishers could access these services within their local health jurisdiction. Nevertheless, small-scale fishers should be encouraged to take care of their health to prevent sickness and convenient access to health care services should be provided.

Conclusion and Way Forward

The interviewed fishers in Ban Hat Sai Khao Village had access to financial services through the policies and programs of the government. To sustain the fishing activities of small-scale fishers for sustainable livelihood, well-being, and food security, low-interest rates should be considered in the development of appropriate financial assistance programs. The financial service scheme should be promoted by financial institutions to small-scale fishers and should be easy to access by using a digital platform. Thereafter, the capacity of fishers to access financial services should be enhanced by conducting training as well as awareness-raising activities on the application process for loans and insurance.

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About the Authors

Ms. Thanyalak Suasi is the Head of the Fisheries Management Section, Research and Development Division, SEAFDEC Training Department, Samut Prakan, Thailand. Email: thanyalak@seafdec.org

Ms. Rattana Tiaye is a Fisheries Management Scientist of the Fisheries Management Section, Research and Development Division, SEAFDEC Training Department, Samut Prakan, Thailand. Email: rattana@seafdec.org

Ms. Jariya Sornkliang is a Fisheries Management Scientist of the Fisheries Management Section, Research and Development Division, SEAFDEC Training Department, Samut Prakan, Thailand. Email: jariya@seafdec.org

Boosting the sustainability of aquaculture feed for the lucrative business of mangrove crab grow-out culture

Myrna N. Bautista-Teruel and *Rhiannen Marie C. Licera*

Keywords: mangrove crab, *Scylla serrata*, nutrition, grow-out culture

Conventional feeds for mangrove crab (*Scylla serrata*) are highly fixated on the use of fish-by-products (FBC) and other slaughter wastes. These feeds, however, are highly polluting that can easily cause water quality spoilage, and may affect the health of the mangrove crab. They can likewise bring about problems in supply shortage, reliability in quality, and as carriers of disease agents.

In order to support the sustainability of the mangrove crab industry in Southeast Asia, there is a need to produce an efficient and viable aquaculture feed for this species. Although SEAFDEC has started venturing into researches with emphasis on crab feed development, it was deemed necessary to work on further improvement of feed formulation with the inclusion of ingredients that are less expensive based on published nutritional requirements and physical properties of mangrove crab.

This study assessed the efficiency of the refined crab feed in land-based tanks. Refinement of this feed formulation focused on partial replacement of fishmeal with alternative ingredients such as mussel meat meal. Cholesterol was added to refined crab feed to improve molting processes affecting the growth of the animal (Coloso *et al*., 2017). The same diet was evaluated for its proximate composition, water stability, amino acid and fatty acid compositions, digestibility of nutrients, attractability and palatability, and its biological effects on cultured mangrove crabs. Overall, results indicated that refined crab feed can potentially be used as sole feed for the grow-out culture of crabs as it can enhance the animals' growth and survival in tanks.

The mangrove crab (*Scylla serrata*) farming industry is one of the more lucrative industries in the Southeast Asian region. Its world aquaculture production was pegged at 248,800 t and approximately 2.2 % of the total crustacean production (FAO, 2022). This figure of mangrove crab may well be expanded for better sustainability of the industry. Its further expansion may enable the provision of livelihood opportunities especially in remote control communities. However, this may entail the need to produce an efficient and viable aquaculture feed that may provide all the nutrients required by the animal.

Several research studies have been conducted and have shown that mangrove crabs are able to accept alternative feed options such as dry-formulated feed. Researches focused on their nutritional requirements which are very useful in the formulation of nutritionally balanced and cost-effective diets. Feeding trials did not show any significant difference in growth, molt, and survival with diets containing 35 % and 40 % crude protein (How-Cheong *et al*., 1992). In the study of Unnikrishnan and Paulraj (2010), on the other hand, mangrove crab's best growth performance as well as nutrient turnover was recorded with 45 % crude protein in the diet. Lipid requirement ranged from 5.3 % to 13.5 % (Sheen & Wu, 1999). Sheen (2000) reported that 0.5–0.79 % dietary cholesterol level is adequate for higher weight gain in *Scylla serrata*. Reports are available for the essentiality of highly unsaturated fatty acids for juvenile mangrove crabs (Sheen & Wu, 2002).

SEAFDEC likewise has started venturing into researches with a focus on crab feed development in different stages. The use of synthetic binders in the feed resulted in higher pellet water stability. The apparent digestibility coefficient of the nutrients varied among the different binders tested (Catacutan *et al*., 2003). Reports have shown that a formulated diet with 48 % protein and an energy level of 1,723 MJ/kg when fed to mangrove crabs showed survival of up to 60 % (Catacutan, 2017). Effective attractants are a strict recommendation for incorporation in the feed formula for better diet attractability. Water stability must be strictly considered since crabs are slow-eating animals. Physical properties of the feed such as size, shape, or texture can likewise affect its acceptability to the animal. Feeding trials showed mangrove crabs eating more with spherical- and tubular-shaped diets (Coloso, 2017). Further, the preference of the animal for attractants such as *Ascetes* and squid meal was highly noted.

To boost the performance of a refined crab feed formulation as the sole source of feed for the mangrove crab, refinement was done using other ingredients such as mussel meat meal and cholesterol. Refined crab feed (RCF) in combination with fish-by-catch (FBC) at different ratios was tested parallel to commercial crustacean feed (CCF) for mangrove crabs.

Promoting positive growth and survival of mangrove crabs

The feeding trial was done to test the efficiency of a refined crab feed to 30 juvenile crabs (0.4–0.8 g) for 150 days. Fifteen 250-L fiberglass tanks (**Figure 1**) were utilized to follow a completely randomized design (CRD) of an experiment. Each tank was equally divided into two partitions using a corrugated plastic sheet to accommodate two individual mangrove crabs. Dietary treatments consisted of **T1**: 0 % RCF:100 % FBC; **T2**: 50 % RCF: 50 % FBC; **T3**: 75 % RCF:25 % FBC; **T4**: 100 % RCF:0 % FBC; and **T5**: 100 % CCF. Each treatment was randomly distributed in three tanks.

Figure 1. 250-L experimental tanks for mangrove crabs

The mangrove crabs fed on refined crab feed (RCF) as sole feed given showed significantly higher growth rates in terms of body weight gain, carapace width, length gain, and specific growth rate as compared to trash fish or commercial feed fed singly. No statistical difference, however, was observed in the growth of crabs fed 100 % RCF and crabs fed the combination feeds (50 % RCF: 50 % FBC and 75 % RCF:25 % FBC). Feed conversion ratio (FCR), though statistically comparable among experimental diets, was observed to be lowest in crabs fed RCF alone. Moreover, the survival rate (% SURV) was much higher for crabs fed 100 % RCF compared to the survival in other treatments. Crabs given 100 % RCF also showed the shortest average intermolt period and the highest molting frequency. Overall, comprehensive findings from this study suggest that feeding the mangrove crabs with 100 % RCF) yielded significantly higher growth and survival as compared to 100 % feeding of either traditional (trash fish) or commercial feed. Growth of mangrove crab fed with 100 % RCF in a land-based tank for 150 days is shown in **Figure 2** and **Figure 3**.

Figure 2. Initial carapace width (16.0 mm) of crab fed with 100 % RCF

Figure 3. Final carapace width (59.0 mm) of crab fed with 100 % RCF after 150 days

Enhancement of feed's nutritional profile

The improvement in growth and survival of mangrove crabs fed with 100 % RCF can be attributed to the refinement of the current feed formulation which is based on published nutritional studies on the grow-out culture of mangrove crabs. The formulation contains dietary nutrients that are within the range recommended for mangrove crabs. Crude protein for RCF at 50 %, is close to the levels recommended for good growth of crabs (Catacutan *et al*., 2017; Unnikrishnan & Paulraj, 2010). The analyzed crude fat of 6.47 % corresponds to the optimum requirement suggested by Catacutan (2017) as well as Sheen and Wu (1999). The level of NFE or digestible carbohydrate in the diet at 26.38 % is within the 20–30 % range required by crustaceans (Wang *et al*., 2016). Crude ash, which is crucial for the molting, growth, and survival of crustaceans, is at 11.18 %. This level is slightly lower than the figure presented by Catacutan (2017) at 15 %. The bioavailability of essential amino acids and fatty acids in the RCF is comparable to the profiles in mangrove crab flesh which can be considered as contributory to the animal's positive growth.

The inclusion of certain feed ingredients such as cholesterol and mussel meat meal has also contributed to the improvement of the performance of RCF. Cholesterol, supplemented at 0.5 % in the RCF, is found to be an essential nutrient compound that plays a vital role in the physiological processes of crustaceans (Kumar *et al*., 2018). In a preliminary study conducted by Coloso *et al*. (2017), it was determined that the addition of dietary cholesterol to feeds can enhance the mangrove crab's molting success and survival. Furthermore, an analogous study by Sheen (2000) revealed that the lowest survival rate and molting frequency were observed in crabs fed a diet without cholesterol supplementation. Sheen (2000) also suggested that the optimum dietary cholesterol requirement for mangrove crabs was 0.51 %. Mussel meat meal, on the other hand, was used to partially replace fishmeal in the formulated diet. According to studies conducted by Berge and Austreng (1989), Jönsson *et al*. (2011), and Rasidi (2022), mussel meat meal has an excellent nutrient profile that is comparable with that of fishmeal thus making it a great alternative to the latter. Additionally, mussel meat has also been recognized as a good feed attractant and palate stimulant (Berge & Austreng, 1989; Nagel *et al*., 2013). Results of attractability and palatability tests using a rectangular maze system and Y-maze system for RCF and CCF in the present study further confirm these findings as RCF containing 21 % mussel meat meal was deemed more attractive and palatable by crabs than CCF.

The rectangular maze system (**Figure 4**) made use of a glass aquarium divided by two barriers, thereby forming three compartments. The crab was placed in the middle section of

Figure 4. Rectangular maze setup for feed attractability and palatability tests for mangrove crab

Figure 5. Y-maze setup for feed attractability and palatability tests for mangrove crab

Figure 6. Chromic oxide analysis of feeds and feces for digestibility study (clockwise: thawing of collected frozen species; ashen feeds and feces samples; concentrated digested sample; and diluted digested samples for spectrophotometer reading)

the aquarium, while test diets (RCF and CCF) were placed into the two outer compartments. The barriers were pulled out 10 min after the feeds were placed. The Y-maze system (**Figure 5**), on the other hand, utilized a y-shaped, wooden setup. The crab was isolated in the central chamber of the y-maze by a wooden gate, whereas RCF and CCF were placed in the arm chambers of the system. The wooden gate was lifted 10 min after the feeds were placed. Video recording was conducted for both systems to quantify the time at which the crab had first contact with either feed (attractability) and the time at which the crab had fully consumed the feeds (palatability).

Good nutrient digestibility and high water stability in RCF were also considered crucial factors in the superior performance of the formulated feed in the growth and survival of crabs. **Figure 6** shows some of the methods in the chromic oxide analysis of feeds and feces for the digestibility study. The apparent digestibility tests for dry matter, crude protein, and crude fat of RCF and CCF revealed that RCF was more efficiently digested by the experimental animals than CCF. The apparent dry matter digestibility (ADMD = 83.20 %), apparent crude protein digestibility (ACPD 93.70 %), and apparent crude fat (ACFD = 97.10 %) values for RCF were close to the levels in the crab reference diet formulated by Catacutan *et al*. (2003). Both the RCF and CCF exhibited considerably high percent stabilities even after 24 h of submersion in water. Since crustaceans such as crabs are slow-eating animals, a physically stable feed that can withstand being submerged in water for several hours without disintegration is a must (Obaldo *et al*., 2002).

Way Forward

Mussel meat meal and cholesterol were supplemented as means of refinement for the mangrove crab grow-out feed. The 100 % provision of refined crab feed enhanced the growth and survival of the experimental animals in land-based tanks. For a better understanding of the success of the tank study on the refinement of formulated diet for the mangrove crab culture, a similar study will be conducted in brackish water ponds using the same *Scylla serrata* species.

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About the Authors

Dr. Myrna N. Bautista-Teruel is a visiting scientist at the Nutrition and Feed Development Section, Research and Technology Verification and Extension Division, Aquaculture Department, Southeast Asian Fisheries Development Center, Tigbauan, Iloilo 5021, Philippines (Email: mbteruel@seafdec.org.ph)

Ms. Rhiannen Marie C. Licera is a Technical Assistant at the Nutrition and Feed Development Section, Aquaculture Department, Southeast Asian Fisheries Development Center, Tigbauan, Iloilo 5021, Philippines (Email: rhiannenmarieclicera@gmail.com)

Guide to Contributing Articles

Fish for the People is a policy-oriented Special Publication produced by the Southeast Asian Fisheries Development Center (SEAFDEC). The first issue of the Special Publication was launched in early 2003 to commemorate the first anniversary of the ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security in the New Millennium: "Fish for the People" organized in 2001 from which the Special Publication got its banner title *Fish for the People*. Through the years, *Fish for the People* has been recognized by various stakeholders as a significant source of information to support their works on the sustainable development and management of fisheries and aquaculture in the region. The SEAFDEC Secretariat publishes three issues of the Special Publication each year with support from the Japanese Trust Fund. The publication of articles in *Fish for the People* is free of charge.

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CALENDAR OF EVENTS

Date	Venue/mode	Event	Organizer
		2023	
4–8 September	Samut Prakan, Thailand	Regional Practical Training Course on Google Earth Engine and Oceanographic Data Visualization	SEAFDEC/TD
4–9 September	TMS, Philippines	Training Course on Fish Nutrition & Feed Development	SEAFDEC/AQD
4–13 September	TMS/IMS, Philippines	Training Course on Micropropagation and Nursery Culture of *Kappaphycus*	SEAFDEC/AQD
11–15 September	Bergen, Norway	19th Session of FAO Sub-Committee on Fish Trade	FAO, Norway
18–22 September	BFS, Philippines	Training Course on Catfish Hatchery and Grow-out Operations	SEAFDEC/AQD
18–27 September	TMS, Philippines	Training Course on Mangrove Crab Nursery and Grow-out Operations	SEAFDEC/AQD
23–24 September	Bangkok, Thailand	Workshop on Abundance Estimation of Marine Debris Using Pier Monitoring Data	SEAFDEC/TD
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2–9 October	TMS, Philippines	Training Course on Pompano & Red Snapper Seed Production	SEAFDEC/AQD
3-6 October	Kota Kinabalu, Sabah, Malaysia	Regional On-Site Training on Chondrichthyans Taxonomy, Biology and Data Collection	SEAFDEC/MFRDMD
9–26 October	TMS, Philippines	RECAB 2023: Regional Training Course on Advanced Aquaculture Technologies for Commercially Important Commodities in Southeast Asia	SEAFDEC/SEC & AQD
23-27 October	Bangkok, Thailand	Regional Workshop for Asia on the 2022 FAO Voluntary Guidelines for Transshipment	FAO
26–27 October	Dili, Timor-Leste	16th RPOA-IUU Coordination Committee Meeting	RPOA-IUU
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6–21 November	TMS, Philippines	Training Course on Sandfish (*Holothuria scabra*) Seed Production, Nursery & Management (Session 2)	SEAFDEC/AQD
6 November – 13 February 2024	TMS, Philippines	Distance Learning Course on Basic Principles of Health Management in Aquaculture (Online)	SEAFDEC/AQD
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6–8 December	Bangkok, Thailand	Regional Workshop on Fisheries-related Other Effective Area-based Conservation Measures in the Bay of Bengal and Southeast Asia	FAO in collab. with IUCN
6–8 December	Entebbe, Uganda	First Global Workshop Between Regional Fishery Bodies and Basin Management Organizations for Scaling Up Cooperation Towards Sustainable Inland Fisheries in the Context of Food Security and Nutrition	FAO
11–15 December	Kuala Lumpur, Malaysia	Regional Training on the Stock and Risk Assessment of Two Seerfish Species in the Southeast Asian Region	SEAFDEC/MFRDMD
12–13 December	Bangkok, Thailand	Inception Meeting for the Project Sustainable Management of Fisheries, Marine Living Resources and Their Habitats in the Bay of Bengal Region for the Benefit of Coastal States and Communities (BOBLME Phase II)	SEAFDEC/TD
14 December	Bangkok, Thailand	Steering Committee Meeting for the Project BOBLME Phase II	TD

Southeast Asian Fisheries Development Center (SEAFDEC)

What is SEAFDEC?

SEAFDEC is an autonomous intergovernmental body established as a regional treaty organization in 1967 to promote sustainable fisheries development in Southeast Asia. SEAFDEC currently comprises 11 Member Countries: Brunei Darussalam, Cambodia, Indonesia, Japan, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Viet Nam.

Vision

Sustainable management and development of fisheries and aquaculture to contribute to food security, poverty alleviation and livelihood of people in the Southeast Asian region

Mission

To promote and facilitate concerted actions among the Member Countries to ensure the sustainability of fisheries and aquaculture in Southeast Asia through:

i. Research and development in fisheries, aquaculture, post-harvest, processing, and marketing of fish and fisheries products, socio-economy and ecosystem to provide reliable scientific data and information.
ii. Formulation and provision of policy guidelines based on the available scientific data and information, local knowledge, regional consultations and prevailing international measures.
iii. Technology transfer and capacity building to enhance the capacity of Member Countries in the application of technologies, and implementation of fisheries policies and management tools for the sustainable utilization of fishery resources and aquaculture.
iv. Monitoring and evaluation of the implementation of the regional fisheries policies and management frameworks adopted under the ASEAN-SEAFDEC collaborative mechanism, and the emerging international fisheries-related issues including their impacts on fisheries, food security and socio-economics of the region.


Secretariat

TD

MFRD


AQD


MFRDMD


IFRDMD

SEAFDEC Addresses

Secretariat

P.O. Box 1046
Kasetsart Post Office
Bangkok 10903
Thailand
Tel: (66-2) 940-6327
Fax: (66-2) 940-6336
E-mail: *secretariat@seafdec.org*
http://www.seafdec.org

Training Department (TD)

P.O. Box 97
Phrasamutchedi
Samut Prakan 10290
Thailand
Tel: (66-2) 425-6100
Fax: (66-2) 425-6110 to 11
E-mail: *td@seafdec.org*
http://www.seafdec.or.th

Marine Fisheries Research Department (MFRD)

52, Jurong Gateway Road,
#14-01, Singapore 608550
Tel: (65) 9046-4787
Fax: (65) 6334-1831
E-mail: *Ong_Yihang@sfa.gov.sg*
http://www.seafdec.org

Aquaculture Department (AQD)

Main Office:
5021 Tigbauan, Iloilo, Philippines
Tel: +63 33 330 7000
Fax: +63 33 330 7002
Manila Office:
Room 100-E, Ground Floor
Philippine Social Science Center (PSSC)
Commonwealth Avenue, Diliman
1101 Quezon City, Philippines
Tel & Fax: +63 2 8927 7825
E-mail: *aqdchief@seafdec.org.ph*
http://www.seafdec.org.ph

Marine Fishery Resources Development and Management Department (MFRDMD)

Taman Perikanan Chendering,
21080 Kuala Terengganu, Malaysia
Tel: (609) 617-5940
Fax: (609) 617-5136
E-mail: *mfrdmd@seafdec.org.my*
http://www.seafdec.org.my

Inland Fishery Resources Development and Management Department (IFRDMD)

Jl. Gub. HA. Bastari No.08
RT.29 RW.27 Kel. Silaberanti
Kec. Seberang Ulu I, Jakabaring, Palembang 30252
Sumatera Selatan, Indonesia
Tel: +627115649600; Fax: +627115649601
E-mail: *ifrdmd@seafdec.id*
http://www.seafdec.id

The fourth prize winner, *San Nisa*, from the national drawing contest in Cambodia

National Drawing Contests were organized in all ASEAN-SEAFDEC Member Countries as part of the preparatory process for the ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security Towards 2020 "Fish for the People 2020: Adaptation to a Changing Environment" held by ASEAN and SEAFDEC in June 2011 in Bangkok, Thailand, in order to create awareness on the importance of fisheries for food security and well-being of people in the region.