

Achieving Sustainable Aquaculture in Southeast Asia: a case study on community-based giant freshwater prawn production in Laguna Lake, Philippines

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Giant freshwater prawn (*Macrobrachium rosenbergii*) juveniles for stocking in hapa nets in ponds at Calauan, Laguna, Philippines

The Aquaculture Department of the Southeast Asian Fisheries Development Center (SEAFDEC/AQD) implemented the project “Sustainable Aquaculture through Cost-effective Culture Systems, and Prompt and Effective Aquatic Animal Health Management” from 2020 to 2024 with support from the Japanese Trust Fund (JTF). The Project consists of three main activities: 1) cost-effective culture system, 2) prompt and effective aquatic animal health management, and 3) capacity enhancement for sustainable aquaculture. It complies with Resolution No. 16 *Strengthen aquaculture governance and implement good aquaculture practices to sustain production for food safety and security, sustainable livelihoods, and rural development of the ASEAN-SEAFDEC Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2030 (RES&POA-2030).*

Recognizing the success and expertise of AQD in the development of aquaculture technologies, especially in broodstock management, spawning, larval rearing,

nursery and grow-out culture of aquatic fish, crustaceans, mollusks, sandfish, and seaweeds, feed development, fish health management, development of vaccine treatment, protective measures against existing and emerging diseases, community-based resource management, and implementation of aquaculture-related training courses, the Project was conducted to improve the stability and sustainability of aquatic food production and for technology dissemination in the Southeast Asian region. Under Activity 1 of this Project, this study aims to establish a community-based seedlings supply system.

This article highlights the inherent challenges of hatchery production, particularly our growing vulnerability to climate variability, including temperature fluctuations and water quality issues. Effective data monitoring can guide adaptive management strategies through science-based strategies, such as investing in appropriate technologies, adjusting densities, and changing feeding practices to boost production yields.

In 2022, aquaculture achieved a historic milestone by surpassing capture fisheries production as the primary aquatic producer. Its global production reached 130.9 million t, with 94.4 million t being aquatic animals, marking a 4.4 % surge from 2020 (FAO, 2024). However, the rapid growth of aquaculture has brought about a pressing need for urgent improvements in the culture systems. The development of aquaculture is facing challenges and issues such as degradation of the culture sites, destruction of sensitive ecosystems, decrease in biodiversity, spread of diseases, and social conflicts that must be addressed promptly. It is crucial that we shift our focus towards sustainable aquaculture, which should not only be economically but also environmentally, ecologically, and socially sound. This underscores the urgency of our actions in this field, making the need for immediate action palpable and the audience aware of the critical nature of the situation.

The giant freshwater prawn or GFP (*Macrobrachium rosenbergii* De Man 1879) is widely distributed in the tropical and subtropical countries in the Indo-Pacific Region, including Bangladesh, Myanmar, Cambodia, India, Indonesia, Malaysia, Pakistan, Philippines, Sri Lanka, Thailand, and Viet Nam (Soesanto, 1980). GFP is recorded to be found primarily in freshwater bodies such as river systems, streams, lakes, swamps, and even reservoirs connected with the sea, where the mature females lay eggs; the larvae hatch and develop into juveniles. Being catadromous, these juveniles migrate through the river into the brackishwater seashore to spawn. Fishing for this species over the centuries usually involves traps, cast nets, and gillnets.

However, fishing for GFP has evolved to an intensive exploitative level in response to the high demand both at the local and international markets. Some activities, such as the construction of dams, roads, and factories along some river systems, reduced the dispersal area of the GFP, including the spawning and feeding grounds (Soesanto, 1980). Fishing communities must be introduced to hatchery practices and rearing techniques to prevent the continuous decline in GFP production.

In the Philippines, GFP is locally called “ulang” in Tagalog, “udang” in Ilocano, “kissing-kising,” “urang,” “paje,” “padao,” “kalig,” “urang” and “budsang” in other dialects. It used to comprise the native delicacies in communities along river systems. Like other tropical and sub-tropical countries, the indiscriminate fishing activities and habitat destruction caused the decline of the wild GFP stocks in the Philippines. Nowadays, GFP is rarely available in fish markets in Metro Manila and other major consumption centers near freshwater bodies around the Philippines. In 2022, there was an almost 50 % reduction in the annual production quantity of GFP in the country at 691.36 t relative to 1,311.94 t in 2018 (PSA, 2023).

Given the declining GFP stocks in the wild and the increasing demand in local and foreign markets, research on the domestication and propagation of GFP in captivity emerged. The complete metamorphosis of GFP was first recorded in Malaysia in 1962 (Ling, 1969). Farming of GFP has already been conducted in several countries around the globe (New *et al.*, 1985; Son *et al.*, 2005; Aralar *et al.*, 2007; Eguia *et al.*, 2009 Aralar *et al.*, 2011). The success of the mass production of GFP, which started in the mid-1970s, is most notable among the countries where GFP farming was implemented. In the Philippines, farming *M. rosenbergii* in cages in lakes is a viable alternative to pond culture and can potentially improve aquaculture production in lakeshore fish farming communities (Aralar *et al.*, 2007). Laguna Lake, which covers 90,000 ha, is the largest freshwater lake in the Philippines. Although shallow, with an average depth of 2.8 m, Laguna Lake may host the culture GFP in cages in a mono or polyculture system. Its proximity to urban Metro Manila means huge demand for GFP from the growing population and gourmet diners. However, to date, mass production of GFP has not been attained primarily due to a lack of juveniles to supply grow-out enterprises.

Aquaculture contributes to the local economy through increased fish food supply. However, social and environmental issues constrain GFP production in Laguna Lake and its tributaries. Some problems affecting aquaculture in Laguna Lake include environment-related issues, lack of access to low-cost capital, obstruction of navigational lanes by fish pens, illegal fish pens, poaching, and overall limited support from the government (Israel, 2007). This may prevent the application of the GFP culture techniques in this area. To address the industry-wide constraints and to improve support for GFP production, it is indispensable to encourage networking among stakeholders, such as the fish farming households, traders, and local government on the municipal shores of Laguna Lake and its tributaries. Community livelihood assets could be mobilized through participatory methods involving the local stakeholders (Wagle *et al.*, 2012). Thus, national government agencies, such as the Laguna Lake Development Authority (LLDA) and the Bureau of Fisheries and Aquatic Resources (BFAR), should also be consulted if necessary. In this study, developing community-based livelihood strategies is proposed to resolve the social issues confronting the introduction of aquaculture operations in Laguna Lake.

GFP aquaculture for sustainable livelihoods

A community-based sustainable aquaculture livelihood (CBSAL) study was conceptualized in 2017 to improve GFP production, mainly by addressing the need for juveniles for grow out of the GFP production sector in areas surrounding Laguna Lake in southern Luzon, Philippines (**Figure 1**). The CBSAL study was conceived and developed in the context

of a sustainable livelihood approach (SLA) for developing aquaculture-based income-generating activities. These five livelihood assets include human, environmental, physical, financial, and social assets. Given the SLA approach, the specific activities of the CBSAL study included 1) social and organizational preparation methods; 2) GFP aquaculture information dissemination and training in economically viable seed production, nursery, and grow-out; 3) fisheries management and governance; 4) social marketing and enterprise development; and 5) periodic impact assessment in terms of economic benefits, social development, and environmental sustainability. Overall, these SLA principles support a sustainable state resulting from the interaction of economic development, social stability, and environmental integrity (**Figure 2**).

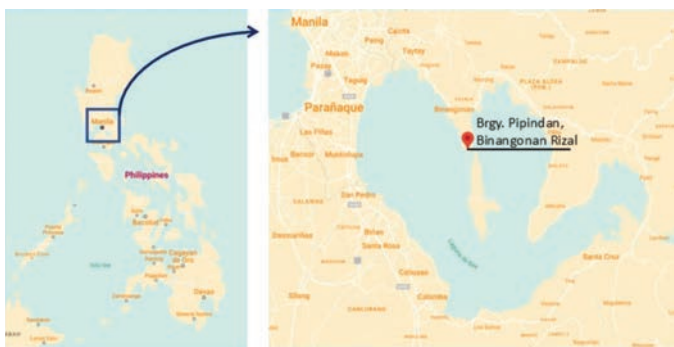


Figure 1. Study site location of the CBSAL hatchery in Laguna Lake in Brgy. Pipindan Binangonan, Rizal, Philippines



Figure 2. A sustainable state from the interaction of economic development, social stability, and environmental integrity

However, the COVID-19 pandemic occurred in the first quarter of 2020 and the Government of the Philippines strictly imposed community quarantine at all levels. The pandemic and its control measures unintendedly created imminent, medium, and long-term food security challenges. It affected food production processes, access to staple food, and trade (Hossain *et al.*, 2020). Despite the negative impacts, some good outcomes emerged, such as more collective and cohesive localized activities like food sharing and the revival of local food networks involving direct marketing and deliveries (Bennett *et al.*, 2020). Nonetheless, there are suggestions to mitigate the impacts, namely, 1) evaluation of principles about

measuring food system resilience and 2) analysis of impacts, actors and responses of actors in the food system (Béné, 2020). In complementation with the sustainable goals described in **Figure 2** and considering the COVID-19 pandemic situation, community resiliency was factored into the conceptual and methodological framework of the CBSAL project.

The aims of the CBSAL study were to: 1) develop community-based strategies to promote the adoption of hatchery technologies for the production of GFP seeds for grow-out and exploratory ranching in Laguna Lake and tributaries; 2) enhance aquaculture skills and entrepreneurial competencies of fish farmers to sustain privately-owned family-based grow-out of GFP in cages in Laguna Lake and tributaries and ponds in lakeshore areas; 3) formulate local policies, regulations and governance strategies, for sustaining livelihoods of fish farmers through production of GFP in communities around Laguna Lake and tributaries; and 4) determine the value chain for GFP to motivate sustainable and profitable GFP industry involving a functional network of hatcheries, nurseries and grow-out farms in Laguna Lake and tributaries.

Milestones of the CBSAL study

The implementation of the CBSAL study started in April 2020. Unfortunately, it faced pandemic-related challenges, such as mobility restrictions on travel for on-site activities. Despite the challenge, organizational activities such as project orientation and social preparation for fisherfolks and the local government of Brgy. Pipindan in Binangonan, Rizal, were not hampered. Meetings were conducted online, and communications were via a group chat named CBSAL-Pipindan. However, not all fishers involved in the CBSAL study have cell phones, computers, and internet access; thus, SEAFDEC/AQD provided them funds to purchase internet time during the online sessions.

Through these online meetings, the fishers and the local government in Brgy. Pipindan were informed about the CBSAL Project, precisely its background, objectives, methodologies, strategies, and expected outputs. A tri-party collaboration between the fishers, the local government unit (LGU) of Brgy. Pipindan, and SEAFDEC/AQD was agreed in August 2020. A series of legal reviews were conducted prior to the signing of the terms of the Memorandum of Agreement (MOA). In 2021, the Pipindan Aquaculture Producers Association (PAPA) was organized along with the election of its officers (**Figure 3**) and the approval of its By-laws and Constitution among its members. In the same year, an online CBSAL-SLA questionnaire was administered through hybrid online and face-to-face interviews to gather baseline information on the socioeconomic status of the community and gauge their perceived rating on their primary capital assets. The data from SLA assets are integral in the determination of project intervention the community needs and prioritization of project funds.



Figure 3. The elected Pipindan Aquaculture Producers Association (PAPA) officers during their oath-taking in 2021

When travel restrictions were lifted in March 2022, the MOA between SEAFDEC/AQD and the LGU of Pipindan, together with PAPA, and the Usufruct Agreement (UA) between SEAFDEC/AQD and the lot owner of the hatchery site were signed by all parties. Thereafter, several activities were implemented, such as hands-on training on GFP seed production and community-based freshwater aquaculture, organizational enhancement, financial management, income-generating operations, site visits, and networking for the members and officers of PAPA. Postlarvae produced during the hands-on training in the temporary hatchery at the Binanganon Freshwater Station of AQD were sold to some tilapia growers in Laguna Lake. Some juveniles were also grown in fishponds in Calauan, Laguna.

The grow-out trials using PAPA-produced GFP juveniles started in January 2023. They were conducted in collaboration with the Philippine Business for Social Progress-Center for Rural Technology Development (PBSP-CRTD) in Calauan, Laguna. The grow-out trial started with transporting 1,100 individuals of advanced juvenile > 2.5 cm tail length, with a survival rate of 97.9 %. Around 1,000 juveniles were stocked in four units of hapa nets (5 m × 5 m) in a pond (20 m × 33 m) with an average water depth of about 0.7 m that were initially rice paddies and then used for tilapia breeding. Supplemental feeding with a GFP diet was applied, and the final harvest was done after 194 days of culture.

The monitoring data showed that the month-to-month recovery rate, average body weight, and tail length improve as the GFP individual grows over time. However, the cumulative recovery rate in relation to the initial stocking number continuously declined. During the grow-out period, high ambient temperature (> 30 °C), stagnant water in the corner of the pond away from the water inlet and outlet, high ammonia load in the water, and filthy water quality were possible causes

of the mortality and decay of some individuals in the cages collected during the monthly sampling. However, during harvest at six months of culture, the GFP escapees from the cages showed bigger body weight and length.

The construction of the small-scale GFP hatchery/nursery building in Brgy. Pipindan took place from July to September 2022, while tanks and utilities, including a small-scale solar power setup, were set up until May 2023. In July 2023, the CBSAL hatchery in Brgy. Pipindan was completed, operational, and inaugurated (**Figure 4**). The hatchery obtains freshwater from the local Pipindan Community Multi-Purpose Cooperative Water. The hatchery is powered alternately by solar setup and the commercial power provider in the country. However, the initial larval-rearing activities were met with challenges, including problematic postlarvae (PL) production in 2023.



Figure 4. The CBSAL GFP hatchery in Brgy. Pipindan (below) and its inauguration with SEAFDEC/AQD, LGU officials, and fishers

The problematic larval rearing runs were thoroughly analyzed through consultations and various larval rearing explorations. Looking back, water bodies and water quality have deteriorated, including Laguna Lake, where the GFP larval rearing in the PAPA hatchery draws water through the local domestic water service provider. Some contaminants from the factories and human settlements, and other aquatic organisms could have hindered the production of GFP PL in 2023. In 2024, the CBSAL study mainly focused on upgrading the hatchery facilities and installing cartridge filters and UV sterilizer. Larval rearing proceeded using filtered and UV-treated artificial brackishwater, and implementing the improved feeding and siphoning protocol in the hatchery. In July 2024, PL were produced and reared until PL30. The PAPA

organization resumed selling PL to grow-out operators around Laguna Lake. With these successful runs, more larval rearing drums are now in operation. PAPA members are being retrained on improved hatchery protocol in the upgraded small-scale GFP hatchery.

Evaluation of CBSAL

A survey was conducted in February 2023 to evaluate the stakeholders of CBSAL in Brgy. Pipindan. A total of 143 respondents (42 PAPA members, 62 officers from various community organizations, and 39 residents who neither belong to the abovementioned two categories) were interviewed using a structured questionnaire. The respondents comprised 77 % male and 23 % female, with an average age of 51 years, nine years of schooling, and belonging to a household with four members. The 33 % majority completed a high school degree, 22 % had an elementary degree, and 15 % had a college degree. Other respondents were either undergraduates or had no education. Notably, the 28 % majority of the respondents earned a living from fishing, while the rest engaged in periodic and irregular jobs such as carpentry, construction, buy-and-sell of goods, and fish cage workers, among many other forms of livelihood.

Further, the survey results showed that the average monthly household income before the COVID-19 pandemic was PHP 23,486 (USD 427), with a -29.19 % decline to PHP 16,631 (USD 302) during the quarantine period. However, it bounced back to a 32.7 % increase of PHP 22,062 (USD 401) during the post-quarantine period in 2022. Nevertheless, this is still 6.1 % lower than the pre-pandemic income, but given the post-quarantine circumstances of the respondents, the livelihood development objectives of the CBSAL study remain relevant.

Sustainable and resilient hatchery operations are envisioned to generate supplemental income for participating PAPA members and the community of Brgy. Pipindan, Binangonan Rizal. The continuity of successful larval rearing run after some facility upgrades in the community-based “ulang” hatchery facility will pave the way to be the key supplier of juveniles for grow-out, eventually increasing the availability of “ulang” in markets, restaurants, and households.

Moreover, networking, primarily through a Facebook group called “Ulang sa Pilipinas” (GFP in the Philippines), provided PAPA with more comprehensive access to the market while creating and maintaining engagement with the stakeholders in the “ulang” value chain.

Overall, participatory approaches in implementing community-based project activities aid in risk management. The PAPA members and the Pipindan LGU affirmed their participatory role in constructing the community-based hatchery, which

will be the venue for social science research on developing sustainable and resilient livelihood in fishing communities using sustainable aquaculture technologies. This participatory strategy builds a sense of community-based co-ownership and a sustained stake in the hatchery operations.

Way Forward

To further improve the hatchery production scale, it would be beneficial to replicate CBSAL models in Laguna Lake tributaries, particularly in areas known as GFP’s natural habitat. A crucial factor for the success of the CBSAL model is the active involvement of the fisherfolk community and their willingness to integrate new technologies to improve the resilience of the hatchery operations. Hence, to ensure the financial and operational sustainability of the model, it is essential to strengthen stakeholder engagement through collaboration with government bodies, such as LLDA and BFAR, as well as with NGOs, research institutions, academia, and private investors. Additionally, encouraging communities to develop networking strategies and enhance market reach through social media platforms can shorten the production chain and create opportunities for local producers to improve their yields.

As a successful CBSAL model, expanding the reach to other parts of the country and Southeast Asian region on sustainable hatchery practices, adapting to environmental changes, and fostering inclusive growth will ensure that GFP aquaculture contributes to long-term food security, ecological health, and social well-being not only in the local community but also in the region.

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