

Adaptive learning in sustainable aquaculture: Best practices for small-scale shrimp farmers in Thailand

NACA



Shrimp pond with central pit to accumulate waste. A buried drainage line allows periodic cleaning, reducing the amount of organic matter in the pond during growout, reducing disease risk.

Background

“Early Mortality Syndrome” (EMS), of the type more accurately known as Acute Hepatopancreatic Necrosis Disease (AHPND) is causing major losses in marine shrimp aquaculture in Thailand and in number of Asian countries including China, Malaysia, Vietnam, India, Malaysia and the Philippines. The disease, associated with infection by a strain of the bacteria *Vibrio parahaemolyticus* has been found to occur 20-30 days after stocking of shrimp seed. In order to prevent the disease and reduce risk due to the AHPND, it is necessary to use specific pathogen free (SPF) seed as well as good pond preparation and management techniques to stabilise the pond ecosystem and to reduce organic waste in shrimp ponds.

The Petchaburi Model for sustainable white shrimp culture is an applied shrimp culture innovation that was initiated by Thailand’s Department of Fisheries (DOF) in 2014. It is done by growing shrimp in water treated with seaweed culture prior to stocking of shrimp seed in ponds. This method is conducted with other pond management techniques such as the use of quicklime (calcium oxide), cleaning the pond bottom to remove organic matter in between culture cycles, use of microbes, and use live feeds or *Artemia* during the

early period of growing cycle to reduce the buildup of organic matter from uneaten feed. The model is seen as a practical and effective model for reducing risk of AHPND in Thailand.

The principle of the model is now being applied under the project entitled “Adaptive Learning in Sustainable Aquaculture Best Practices for Small-Scale Shrimp Farmers in Thailand (SSSF)” funded by the Walmart Foundation and IDH through the Sustainable Fisheries Partnership Foundation (SFP) and implemented by the Network of Aquaculture Centres in Asia-Pacific (NACA) and The Food School (TFS) in collaboration with DOF, Thailand. The project is aiming at promoting collaboration among small-scale marine shrimp farmers and groups of marine shrimp farmers in Thailand to improve their farm management and to promote environmental friendly practices, prevent disease, stimulate their economies and markets. It is implemented through a participatory approach with regards to stakeholders and role of women in shrimp production and decision making processes. The project targets to improve sustainable marine shrimp culture for about 2,000 small-scale shrimp farmers in Thailand.



Issues addressed

Marine shrimp farmers in Thailand normally grow shrimps in a 1 - 4 rai pond (1 rai = 0.16 ha) and expect a total production of 2 tonnes/rai. With FCR of 1:1.5, feed requirement will be 3-12 tonnes. With feed of 20 kg/pack (1,000 Thai Baht), the total costs of feed will be about 150,000-600,000 Baht/crop of 4 months. Therefore, shrimp farmers have certain risks in producing each crop. Due to the AHPNS, marine shrimp farmers are facing high risks on their investment. They cannot borrow money unless they have information that will convince the banks for future success in their investment.

The project aims to develop local zonal management groups that will be involved in co-management of the local aquaculture industry. The anticipated wider benefits will be reduced environmental impacts of aquaculture through better farm management minimising waste release and water use; improved industry management and coordination of activities between local farms; and better representation of small-scale producers in local aquaculture management dialogues. More specifically for small-scale farmers, better livelihood returns are expected through reduced stock losses and increased diversity of income through improved use of secondary crops from shrimp ponds. The project specifically addresses the needs of women involved in Asian aquaculture, particularly those managing farming activities, marketing, and income.

In the concept and preparation phase for the project, the "Petchaburi Model" was held up as the benchmark for best practices for disease prevention. The term came from a Royal Sea Farming and Aquaculture Demonstration Project in Petchaburi province. The Petchaburi Royal Demonstration Project uses an "integrated, environmentally friendly and

balanced farming system" that in the case of aquaculture, introduces milkfish, *Chanos chanos*, and/or tilapia or a grape-like seaweed, *Caulerpa lentillifera*, also called "green caviar", for sediment treatment and water quality improvement. Some secondary products have been tested for commercial potential.

Partners

The following were among the partners in the management and development of the SSSF-Thailand Project:

- Sustainable Fisheries Partnership Foundation
- Network of Aquaculture Centres in Asia-Pacific (NACA)
- The Food School (TFS)
- DOF, Thailand
- Samroi-yod Small-Scale Farmers' Cooperatives
- Sustainable Shrimp Cooperative of Trad
- Trang Aquaculture Cooperative
- Ranong Shrimp Club
- Thai Union Feedmill Co. Ltd.
- Thai Royal Feedmill Co. Ltd.
- Charoen Pokaphand Feedmill Co. Ltd.

Objectives

The project sought to provide technical and capacity development support (adaptive management and adaptive learning) to selected small-scale farmers in Thailand to develop local strategies for shrimp farming development and to disseminate and adopt better management and best practices that increase productivity and reduce environmental and disease risk. More specific goals were to:

- Restore the confidence of small-scale farmers to grow white shrimp again using science-based best practices, local adaptations and practical innovations to prevent disease.
- Identify and model field-level better management practices that could increase productivity, enhance livelihoods and at the same time reduce environmental and disease risks.
- Engage more women farmers or women in farming communities to raise their visibility, recognition of their roles and contribution in farming and processing.
- Create a multiplier effect of farmer-to-farmer transfer of knowledge, experience-sharing and communication within local communities via existing networks (e.g. shrimp clubs, cooperatives or creation of new groups) that could eventually lead to zonal management.

Activities

The project met with local shrimp clubs and cooperatives, the Shrimp Farmer Association of Thailand, national and provincial government agencies. A survey on existing shrimp farming practices and stakeholder workshops were held involving a total of around 500 farms, to document the existing situation.

Shrimp cooperatives meeting certain criteria (small- to medium scale farmers, women leaders and innovative farmers) were subsequently engaged in establishing demonstrations of better management practices in farms in five provinces of Trad, Prachuabkirikhan, Ranong and Trang, and collecting performance data for comparison with existing practices.

The performance data was presented to assessment workshops attended by 30-40 farmers in each target province, followed by provincial-level seminars to extend the results to farmers more widely, attended in total by around 500 producers.

Outcomes

The project reached out to a total of around 500 small to medium scale farmers directly through the various phases and planned activities. Special attention was given to inclusion of women during the selection of model farms and workshop participants. Based on best available information at that time and reliable local networks, the project team selected four key locations - Prachuabkirikhan, Trad, Trang, Ranong - together with neighbouring provinces of Petchburi, Samut Songkhram, Samut Sakhon, Chanthaburi, Chumphon and Krabi as support. The project was able to extend its reach additional provinces and organisations linked with the farm-

raised shrimp supply chain such as hatcheries, processors, feedmills, chemical and equipment distributors via attending shrimp festivals and seminars organised by the project.

In total the project's outreach was extended to around 2,000 farmers and members of farming communities. Both individuals and communities reported benefits in terms of improved knowledge, income and relationships with other farmers' groups and the Thai DOF.

Women made up 39% of the total participants in project activities but 35% of the farm owners directly involved with shrimp farming. The workshops also caught the interest of women's groups involved with post-harvest and processing, who attended or indicated an interest in participating. Two out of the six model farms were owned and managed by women, who demonstrated levels of productivity and management expertise that were ranked highly both by their peers and the project team. The majority of monitoring personnel from partner organisations consisted of women (12 out of 20). All of the above accomplishments highlight the value and contribution of women as well as build up their visibility and confidence.

The project created a multiplier effect that resonated with shrimp clubs, associations and cooperatives. New groups are being formed, to supplement or enhance existing ones in starting discussions related to zonal management. There are government and private sector-led initiatives for selected provinces that are being finalised and/or in the process of being implemented. Production statistics for 2016 as compared to 2015 show increases in two of the main shrimp producing provinces and four of the supporting provinces. In both years, the share of the provinces where the project was implemented is around 45% of total annual Thai production. We believe that the project has contributed to this growth and stability while at the same time affirmed the importance of best practices and disease prevention amongst shrimp farmers.

The project developed a unique program using core concepts of adaptive learning, an approach that emphasises learning by doing in the field, supplemented by multi-stakeholder workshops and interactive group learning. A key element of the strategy was the use of six model farms in four coastal provinces on the Gulf of Thailand and Andaman Sea.

With support and direction from the project team and the local Thai DOF Centers, the model farms demonstrated in one selected pond within their farm best management practices for one crop cycle. The team documented the whole process from pond preparation, stocking, grow out, harvest and in some cases, post-harvest. Afterwards, the model farms shared their experiences – successes as well as challenges – with other farmers in the province. Through this adaptive learning strategy, the team expected small but significant improvements that could be shared within the community to determine, collectively, potential solutions that could prevent common risks of disease, uphold the principles of sustainable shrimp farming better practices, reduce environmental damage as well as restore confidence and increase productivity.



Evaluation

Assessment workshops were held in mid-July for the farms in Prachuabkirikhan; followed by Trang during early September. Trad and Ranong originally planned for October were advanced to the second half of September; those for sixth farm and a second crop in Prachuabkirikhan, in mid-December. The schedule was advanced for Trad, in particular, due to pending restructuring of the Thai DOF's Coastal Fisheries Research and Development Centres (CFRDCs).

The assessment workshops followed a pattern of internal individual discussions with the model farmers on the crop results, specific challenges, observations and insights they have on what transpired. During these internal assessments, the project team attempted to capture and highlight lessons learned and areas for improvement.

The results of the farmer's evaluation of project impacts by province were carried out by a team from the Network and Information Technology Security Management Group, DOF under supervision of Mr Pongpat Boonchuwong, NACA Mentor/DOF Advisor in Fisheries Economics and Marketing.

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To achieve the project goal and objectives, SFP facilitated the selection of a strong local team of implementers. It tapped into The Food School's field-level technical expertise, good relationships with local farmers, processing plants and overseas buyers, in addition to its experience and credibility in training, auditing and implementing supply chain projects for sustainable seafood systems. NACA, the other implementing partner, is an intergovernmental organisation that coordinated with DOF, Thailand to provide policy support and collaboration as well as to propose a strategic plan for management and implementing the project at the local level. In particular, NACA brought technical expertise and government relationships that complement TFS capabilities. From the government sector, the project received support from the Thai DOF, at the national and provincial levels. The NACA/DOF advisors and mentors; the Director and chiefs of the Marine Shrimp Research and Development Institute; the directors, technical

staff and resource persons from the provincial Coastal Fisheries Research and Development Centers (CFRDCs) were all instrumental in the project's successful implementation. From the private sector, the SSSF Project benefitted from the interest and participation of seafood manufacturers, hatcheries, feedmills, chemical suppliers but most of all from the support of farm cooperatives, shrimp clubs and various local associations.

Impacts and key success factors

Many lessons have been learned – some the hard way, through failure of a crop – but all have made a positive impact on the farmers' livelihood and income; confidence; technical knowledge and skills; capacity to change, analyse, improve; ability to communicate and work in a group as while interacting effectively with other stakeholders, from the private and government sectors.

Oral and written feedback from the farmers showed that they valued highly the discussions, the experience-sharing and the knowledge dissemination. Topics on better shrimp farming practices, disease and preventive measures, access to market and supplies, finance management and record keeping are the ones they learned most about. In particular, the farmers now have a better understanding of what options they have for affordable best practices (specifically for small-scale farms) and how they could adapt and implement these, e.g. for pond preparation, water and sediment handling, animal health, feed management, in their farms to reduce disease risks. Following the experiences of the model farmers, the farmers also realised that better practices are not requirements imposed on them as "trade barriers" but practical guidelines that could improve productivity, hence generate better income from their farms. Such revenue increase was dramatically proven in the case of the two most successful farmers from Prachuabkirikhan and Ranong. All other model farmers, except one, also profited from the pilot crops. The one who did not succeed turned his crop failure into a valuable learning experience and is in the process of analysing his operations and implementing improvements.

Discussions on market access made an impression on the farmers and affirmed their value within the global supply chain. At the same time, they raised questions on how the farmers could have better control over where their products go and how to optimise the opportunities they could have for premium prices for quality, sustainably-produced shrimps. The farmers expressed appreciation for the SSSF Project's efforts to make available information – technical as well as economic – and considered it as a good model for sharing and compiling information, especially because of its support from the Thai DOF, on both national and provincial levels, as well as from private organisations knowledgeable of global markets and standards. The farmers found this credible access to information central to their business and would like to see an ongoing, more centralised channel for directing concerns or seeking guidance.

With regards to standards and certification, many farmers expressed an interest in knowing more as well as eventually working towards some certification, on top of the Thai DOF requirements, to give them global visibility. Their biggest concern, however, is cost. There are some groups eg. processors, NGOs, and overseas groups, willing to support them. However, the farmers feel that, unlike with the SSSF

Project, the gaps (geographical, technical, cultural) between these groups and the farmers are too big. Moreover, there are unwritten pressures that the farmers feel may take away their control and restrict their opportunities.

Some farmers have, during some of the discussions, made known their discomfort with middlemen. They tend to be secretive or do not know which processor and markets the shrimps are sold to. If the farmers had better information, knowing the increasing demand for sustainable quality shrimps, due to various demographic factors and media exposure, the farmers will be better positioned to optimise their opportunities for production and a premium price.

The impact of the project on women has been satisfying and interesting to both the project implementers and the farmers. The successes, commitment and attitudes of the two women model farmers stood out. At the same time, although these are good examples to motivate women to get more directly involved as farm owners, we still see gaps in ways to build up women farmers' confidence so that they could assume leadership roles and their efforts in their own farms can be visibly measured and rewarded. The assessment questionnaire results, for example, brought home a puzzling trend on the tendency of women farmers to get lower price premiums than men.

With regards to sectors that service the farms, eg. hatcheries, feed mills, chemical and equipment suppliers, the farmers appreciated the guidance provided by the SSSF Project regarding appropriate stocking density, use of sustainable non-IUU feed, avoidance of chemicals or care in using them, in cases where they are needed. However, a remaining concern for the farmers is the pressure that they get to overstock, overfeed and overuse these materials under various arrangements that lock them in with certain suppliers.

Better interaction between DOF centers and farmers; motivation for locally adapted best aquaculture practices and management techniques; encouragement of local innovation on natural feed, probiotics as well as secondary products; better recognition of localisation and innovation efforts by farmers; better use of sediment as fertilisers in orchards and other agricultural products – these are all positive impacts that evolved from the examples set by the model farms.

Similarly, the following benefits were observed within the communities where the SSSF Project was implemented: Better communication and experience-sharing among farmers; greater awareness of collective management through best practices, especially co-management of water resources; greater pride in the value of their product to international markets and being part of a global supply chain; more interest in post-harvest activities especially new products that could provide supplementary income; increased awareness of the need for collective preparedness in case of emergency situations especially for those situations that are hard to control e.g. weather patterns, and better understanding of the impact their farms could have on the environment.

Most farmers reported an increased understanding of how to manage effluents to minimise environmental impacts on the land or bodies of water adjacent to or linked to their farms. They also now have better awareness of how to utilise natural water sources carefully to avoid contaminating them

or spreading disease. To this end, for SSSF, the project's technical team and experts worked with the local CFRDCs to establish a monitoring regime and requirements for disease and quality testing of soil, water, sediment, effluents, and antibiotics.

The workshops and the interactions with farmers and government officials at field level all served the purpose of raising greater awareness about on feed with responsible-sourced sustainable ingredients. The IUU issue as it relates to fishmeal, which in turn becomes the raw material for commercial feed, was explained in the broader context of other factors related to responsible wild capture fisheries e.g. fishing seasons, areas, gear type, migrant labor, fishmeal/fish oil alternatives.

Measures to alleviate or prevent environmental impacts in each province were discussed. The farmers received an overview of why programs to restore mangroves, mitigate coral reef damage, and prevent coastal erosion are community activities that need their participation. In addition, efforts by some local centers to promote crab banks or shellfish farming or seaweed culture projects are valuable to the community as they, likewise, restore natural ecosystems.

We received questions about the issue of post-harvest processing. This is an area dominated by women in the farming communities who are involved with family-scale processing, packaging or selling dried shrimp, shrimp paste or shrimp crackers made from undersized shrimps; or secondary products from plants and animals used in water and sediment treatment systems such as dried, salted, smoked, stewed products or fish burgers from milkfish; pickled, salted or dried shellfish, and fresh seaweed. Potentially, such products and activities could generate income and livelihoods for the farmers. Unfortunately, the project did not extend to post-harvest processing. However, there might be a potential future project for this sector.

The SSSF Project emphasised to the farmers the fact that they are intricately linked with local supply chains which in turn are linked to global supply chains. Hence, farmers who wish to be global players, will have to understand and implement the requirements of global markets and consumers. Within the vulnerable groups of women and small-scale farmers, who have limited resources, group membership was proposed as one way of gaining access and opportunity. This idea was well-received and started lively discussions about options for farmers' groups.

Thailand has always had strong local, regional and national farmer groups in the form of cooperatives, shrimp clubs, farmers and processors' associations, and federations and they are slowly but surely incorporating sustainability and zonal management concepts into their discussions. All provinces in the SSSF Project have active farmers' networks – formal as well as informal. The SSSF Project model farmer, Mr Decha Bunloedate, in Prachuabkirikhan, is the head of the Samroyod Small-Scale Farmers' Cooperatives, which has 254 members (only 20% of whom are currently active). In Trad, another model farmer, Mr Boonlerd Chang-Ngam, founded the Sustainable Shrimp Cooperative of Trad that currently has 70 active members. The Trang model farmer, Mr Charoen Yongstar, is a committee member of the Trang Aquaculture Cooperative which has 143 members. The Trang Coop is divided into five zones (made up of provincial



districts). Mr Charoen Yongstar heads one group with 40 members, who meet monthly, visit each other and other farmers in neighboring provinces of Krabi, Satun, Surat Thani and Songkhla. The Ranong model farmers, Mr Tanon Yodpinich and Mr Chokchai Sukjit are partners of the Andaman Banghin Farm. Ranong does not have a coop but it has the Ranong Shrimp Club Led by Mr Amnat Worakit, its nearly 80 members keep informed and actively involved with technical and economic developments within the industry. Women comprise less than 10% of its members but It keeps close contact with farmers' groups and Thai DOF testing laboratories in the provinces of Phang-nga and Chumphon. In Prachuabkirikhan Province, one of the SSSF Project's model farmers, Ms. Siyarut Israwongchai, functions as the secretariat for a newly-formed group called the Aquamimicry Aquaculture Alliance. This is a loose grouping with members from fifteen countries in Asia, Europe and South America. The main goal is to raise sustainable, chemical-free, nearly organic shrimp, both white and black tiger.

On a national level, a newly-formed National Farmers' Council has as Chair of the Advisory Board (Fisheries), a well-respected shrimp farmer who has devoted many years of work to bettering the lives of small-scale farmers. He used to head a federation of cooperatives that negotiated for many years for better access to finance and insurance for small-scale farmers. However, up until now, have been no banks that would lend to or finance projects by small-scale farms. However, this could change if and when credit unions affiliated with farmers' groups are formed under planned reforms to be implemented by the National Farmers' Council, which in addition to a Fisheries chapter, has a separate Agriculture division.

The success of the SSSF Project owes a lot to the strong support from the Thai DOF. This was recognised and praised by the project team and farmers in all the provinces under the scope of the project. It led to a better understanding of the importance of the work of the Thai DOF Marine Shrimp Research and Development Institute and the provincial Coastal Fisheries Research and Development Centers. It became clear that the CFRDCs are indispensable in supporting farmers in each province and would require additional assistance in upgrading facilities and resources in order to provide diagnostics, monitoring and testing for disease, soil and water quality as well as antibiotic residues.

Regarding environmental impacts from shrimp farming and aquaculture, the amendment of the Fisheries Act B.E. 2490 (1947) into the Royal Ordinance on Fisheries B.E. 2558 (2015), now clearly includes aquaculture activities and responsibilities for enforcement. At the moment, detailed, specific Ministerial decrees and notifications are being developed or formalised so the work of government agencies related to aquaculture will require a period of time to stabilise. In spite of the state of flux, there are obviously many positive developments on the institutional side that will benefit the shrimp industry of Thailand and filter down to the individual farmers and farming communities.

Replicability

The SSSF Project was initially envisioned as a training program for 4,000 farmers. However, with challenges posed by a dramatic decrease in the number of farms all over Thailand, the scope was narrowed down to key provinces and a smaller group led by selected model farms. This turned

out to be the right approach as we succeeded in reaching out strategically to the farming areas and farmers' groups significant to the Thai shrimp industry.

The adaptive learning approach we developed by for this project was a departure from the original plan of workshops and classroom training on topics related to disease and best practices. By selecting and supporting model farms in key provinces, the SSSF Project successfully highlighted and demonstrated local knowledge related to those topics. Both successes and failures functioned as field-level practical lessons that farmers encounter in real-life situations, not only theoretical knowledge. The focus on local input gave added confidence and pride to the communities that the SSSF Project operated in. With relatively limited resources, the SSSF Project covered geographically diverse areas in the country; completed many complex activities – in the field and off the field; forged relationships with farmers and farmers' groups in remote areas; communicated and/ or demonstrated important knowledge and skills, within a relatively short period of time.

Challenges

The main difficulties faced during the project period and the lessons learned are as follows:

- There were five successful crops and two unsuccessful ones. The farmers who “failed”, though, were not deterred by the setback. Some spoke honestly to their peers to impart valuable lessons in line with the strategy of adaptive learning. There were financial, personal, technical and institutional benefits that met or exceeded our expectations.
- Five of the six model farms successfully overcame or prevented disease risks and benefitted financially from their crops. Those financial benefits from one crop, in terms of gross income, in the most cases, were equal to or exceeded what they had reported as their previous annual income. All successful crops and even one emergency harvest showed profit.
- The older farmers, who had experienced crop failures or risks due to disease, differed in their techniques for mitigating the situations they encountered. Whatever the case, the experience reinforced or changed their views on their management practices and caused them to review disease factors and options for preventive measures.
- The younger farmers tended to be more receptive and compliant to the recommendations and guidance of the SSSF Project. In particular, one young woman farmer, who did best, showed enthusiasm and motivation to learn and succeed as well as the willingness to take risks. She stood out in her thirst for knowledge, adeptness in seeking information and ability to draw out other farmers' experiences that she can apply to her farm.
- All of the model farmers reported gaining confidence in being able to overcome disease risks. Even the ones who encountered disease incidents and failed crops, took the experience positively and communicated the merits of the project to their peers.

- There are many local innovations in terms of pond preparation, pond structure, probiotics, natural feed, postlarvae breeding programs that are worth documenting in a training manual or videos for dissemination to a wider audience.
- There are still many challenges that farmers, the industry and the government sector face eg. how to cope with changes in weather/impacts of climate change; unpredictable or limited supply of healthy/SPF PLs; insufficient support for good breeding programs; pressures to overstock and overfeed; better guidance for feed management; better diagnostic tools for disease; more information on disease causes and spread together with the current situation in their province and neighboring provinces; better understanding of environmental impacts, sustainability, traceability and zonal management.
- Relationship building and diplomacy in dealing with farmers got a lot of focus for this phase of the project. The SSSF Project Team successfully dealt with sensitive crop failure situations, analysed them together with the farmers, and turned them into learning opportunities and (for some) financial gain.
- Separate project team assessments and peer assessments were less confrontational. The internal assessment scoring tool is a good guide as it captures not only the end result but the process of implementation, attitudes, motivation and willingness to improve. Honest information on both failed or successful crops are valuable learning opportunities. It is important to disseminate lessons learned to a wider audience and in a larger context.

Observations and lessons learned

We learned a lot during the development and implementation of this project. Some of our observations and lessons are listed below, in the hope that they may prove useful to others working on similar issues. Implications for policy makers and development professionals

- Participate in community-based projects that focus, mitigate or prevent environmental degradation e.g. mangrove restoration, coastline erosion prevention.
- Develop clear interpretation guidelines for the amendments to the *Fisheries Act* directly relevant to aquaculture and farms.
- Maintain or enhance breeding programs in order to make available to farmers healthy, affordable PLs, not necessarily limited to *L. vannamei* alone.
- Continue programs researching and testing the effectiveness of probiotics that could mitigate disease risks and improve shrimp health. Make these products affordable to small-scale farmers.
- Consider a centralised service center that could capture farming community concerns, supply information needs, as well as facilitate licensing and monitoring.

- Coordinate with other government agencies as needed to monitor potential environmental impacts to and from shrimp farms. Define what constitutes negative impact to the environment from shrimp farms. Consider potential impacts/risks from climate change.
- Review zonal management policies and develop as needed a program targeted at disease containment in specified zones.
- Continue research on types of disease, causes and preventive measures.
- Interface with divisions in charge of wild fisheries regarding sustainable feed concerns.
- Issue guidelines on best practices for shrimp aquaculture using closed systems.
- Develop farm-level programs to motivate more women to take up shrimp farming.
- Project implementation periods are often short. It would be better to monitor at least two crop cycles.
- Suggest using adaptive learning concepts more than classroom learning and to include demonstration farms for more effective learning.
- Request that baseline questionnaires and reporting formats be sent ahead of time so that they could be reviewed and translated prior to scheduled activities.
- A similar project with greater focus on hatcheries and breeding programs may be useful, as there appears to be a lot of problems and variations in seed quality.
- It would be useful to extend such projects to address issues further up the supply chain and to encompass issues such as zonal management for disease containment and mitigation.
- Review interest in post-harvest related projects as these could supplement farm-related projects and tap into the involvement and contribution of women.
- Know the quality of source water as well as that of water in all other ponds. Keep all reservoirs and ponds clean and implement biosecurity measures for the farm.
- Insist on lower stocking densities; know the SPF status and source of your PLs; obtain documentary evidence to support the hatchery's claims.
- Obtain information on all inputs – PLs, probiotics, chemicals, feed to ensure traceability and safe sustainable materials.
- Note all feed lot numbers received and used. Keep good accurate records of shrimp feeding amounts, growth and health condition.
- Develop internal monitoring systems for optimum parameters for growth e.g. pH, DO, calcium, magnesium, alkalinity, ammonia, nitrite. At the same time, verify these with periodic external monitoring by the local CFRDC or other agencies.
- Maintain good networks among farmers in your area to discuss common problems, co- management ideas or information sharing on technical or commercial matters.
- Join or form farmers' groups that could provide opportunities for training and extension.

Technical suggestions

- Bear in mind that there are cost-effective options for developing a closed system that recycles water after treatment. Expensive technology is not always the answer.
- When considering pond siting and infrastructure, make sure that there will be no potential risks or damage to the environment.
- Prepare a layout of the farm and identify the points, through risk analysis, where there could be disease risks or risks to the environment.
- Pond preparation is crucial to the success of a crop; therefore it must be done thoroughly; monitor and test the soil and water for disease prior to stocking.

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