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Towards sustainable mangrove-shrimp aquaculture through capacity building and partnership in the Mekong River Delta

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ABSTRACT

Vietnam, the world's third-largest shrimp producer, witnessed a surge in shrimp farming when rice fields were converted into ponds, aiming to alleviate poverty in the Mekong River Delta (MRD). However, this growth significantly contributed to the decline of mangrove forests, as indicated by empirical and geospatial data. Local authorities have encouraged the application of "International Principles" to promote sustainable mangrove-shrimp aquaculture in MRD provinces. Tra Vinh, a province with a high rate of mangrove-shrimp farming, faces challenges in applying international standards, particularly for small-scale farmers. Understanding the circumstances in Tra Vinh is crucial not only for local farmers but also for stakeholders in the region. An in-depth review, local needs assessment, and a capacity-building program centred on the Asian Seafood Improvement Collaborative (ASIC) standards were conducted in Tra Vinh. The findings suggest that adhering to ecological/organic shrimp farming based on international standards is the right direction for local shrimp farmers. However, increased awareness alone does not guarantee a shift from traditional to internationally certified sustainable shrimp farming. The study highlights the role of private-private partnerships (PPPs) in facilitating the transition to sustainable mangrove-shrimp farming, emphasising that sustainable practices in the MRD are essential for household income, mangrove forest protection, environmental conservation, and climate resilience.

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HIGHLIGHTS

- The rise of shrimp farming in MRD was a main driver in the region's decline in mangrove forest area.
- Small-scale farmers in Tra Vinh province face difficulties applying the "International Principles" toward better management of shrimp farming.
- Shrimp farmers in Tra Vinh province expressed their interest in applying the ASIC international standard.
- ASIC capacity building should be provided to local farmers and agencies/companies to support international shrimp management standards implementation.

1. INTRODUCTION

Shrimp is one of the most valuable seafood commodities in the world. Shrimp and prawns dominate aquaculture production in coastal areas, constituting more than 60% of the farmed crustaceans in the world. However, the cultivation of shrimps and other aquatic species, nonetheless, is confronted by manifold sustainability issues, including environmental impacts like mangrove degradation, water quality degradation, salt-water intrusion, disease outbreaks (Sivaraman et al., 2019), water use conflicts, privatisation of natural resources (Primavera, 1997), and food safety. Meeting the needs of buyers, especially in developed countries, certifications were born with increasing numbers and requirements for manufacturers to meet standards, notably Aquaculture Stewardship Council (ASC), Best Aquaculture Practices (BAP), and Global Good Agricultural Practices (GLOBAL G.A.P.) The growing trend of the market for product certification requires seafood exporting countries to make efforts to promulgate regulations for sustainable seafood production and consumption.

Vietnam is the third largest shrimp-production country in the world (FAO, 2020). Shrimp is the second most important aquaculture industry in Vietnam - only after catfish – with an export value of around $3.4 billion in 2017 (Rubel et al., 2019), $3.85 billion in 2020 (Luu et al., 2021), $3.9 billion in 2021, and $4.3 billion in 2022 (Tu Nguyen et al., 2022). Shrimp culture has flourished in Vietnam, especially after the Doi Moi economic reforms in the late 1980s. The government allowed farmers to convert rice fields and salt pans, especially in the Mekong River Delta (MRD), to shrimp ponds to promote poverty reduction. Shrimp farming thus becomes the main livelihood for hundreds of thousands of people.

The MRD is a large flat land area located in southern Vietnam. With a total area of approximately 40,000 km^2 (Phan, Le Toan & Bouvet, 2021), it occupies 12% of the country's total area (Lam, 2020). The MRD is the home of over 17.3 million people, accounting for 17.7% of the total population of the whole country. The MRD is the most important economic region of Vietnam as it has the largest agricultural and aquaculture production in the entire country. In particular, aquaculture production was over 3.1 million tons and occupied 70% of the country (FAO, 2022; GSO, 2021). However, the MRD is also the most vulnerable area of the country when it is facing a series of environmental problems including climate change, rising sea levels, coastal erosion, land subsidence and changes in hydrological regimes. One of the reasons for this phenomenon is deforestation with the reduction of mangrove forests in the coastal areas of the MRD. The area of mangroves in the MRD has decreased by nearly half in the past 48 years, from about 185,800 ha in 1973 to 102,160 ha in 2020 (Phan & Stive, 2022).

One of the reasons for the decline of mangrove forests in the MRD is the development of shrimp farming. From 1953 to 1995, 161,277 ha of mangrove forests were converted to shrimp farming

and other uses (Minh et al., 2001). Since 1995, the Vietnamese government has implemented a policy to allocate mangrove forests to households for protection, management, and logging. Under this policy, households could convert part of the contracted mangrove forests to agriculture, aquaculture, and housing, in which shrimp farming was the main driver of forest conversion (Thu & Populus, 2007). As a consequence, the rapid development of shrimp farming in the MRD has contributed to deforestation, erosion and rising salinity levels that are threatening the stability of the entire region (Waugh, 2011). Tra Vinh – a province in the MRD is not an exception. The reduction of mangrove forests has especially occurred in Tra Vinh province, where most natural mangroves have been replaced by shrimp culture areas (Thu & Populus, 2007). This is a worrying trend, as healthy mangroves make important contributions to both climate change adaptation and mitigation, acting as a natural barrier against storms, sea-level rise, and erosion, and have the ability to store and sequester carbon (Salem & Mercer, 2012; SNV, 2019). In addition, mangroves offer important services in maintaining biodiversity and purifying water (Alongi, 2008; Sathirathai & Barbier, 2001). Important as well is that mangrove forests are home to shrimps, crabs, bivalves and fish, among other species, and sustain the livelihoods of coastal communities (Barbier, 2007).

To address the aforementioned situation, in 2017, the Vietnamese Government passed Resolution 120/NQ-CP on Sustainable and Climate-Resilient Development of the MRD, which recognises the challenges of climate change and outlines its vision for a sustainable delta. In terms of development, they state the need to "shift from quantity-based to quality-based development; build new rural areas associated with strong development and application of high technology agriculture, organic agriculture and clean agriculture chain and trademarks". As a result, the trend of mangrove forest protection is highly encouraged to ensure sustainable development in the region. Nguyen et al. (2022) emphasised the triple benefits of mangrove-shrimp farming models from economic, environmental and social aspects. However, the ratio between mangrove forests and water surface in shrimp ponds to bring the maximum profits is often different from the ratio suggested by researchers, varying from 30 to 60% (Bosma et al., 2014; Nguyen et al., 2022; Tuan et al., 1992). In order to meet the growing trend of the international market for product certification, the International Principles for Responsible Shrimp Farming provide the basis upon which stakeholders can collaborate for a more sustainable development of shrimp farming and have been applied in Vietnam. Evidence has shown, however, that local small shrimp farmers found these principles difficult to apply. This is due to the fact that the principle focuses on ecology while the adaptation and social aspects have not received enough attention.

This study investigated how a capacity building programme centred on the sustainable development of shrimp aquaculture based on the Asian Seafood Improvement Collaborative (ASIC) international food standard that aimed to address the challenges of the mangrove social-ecological systems. The area of mangrove cover on each farm, the benefits to the local community and adaptation to climate change have changed the ways in which small shrimp farmers have traditionally farmed shrimp towards sustainable mangrove-shrimp aquaculture in Tra Vinh province. The main objective of the paper is to compare the level of knowledge of stakeholders before and after the training modules and assess their willingness to adopt the Asian Seafood Improvement Collaborative (ASIC) international food standard that has been customised from VietGAP (Vietnamese Good Agricultural Practices) to suit the context of Tra Vinh province. The study results will provide policymakers with the evidence to promote sustainable mangrove forest management through supporting sustainable mangrove-shrimp aquaculture practices in the MRD.

2. METHODOLOGY

2.1. Research site

The research area is in Long Khanh commune and Don Chau commune, Duyen Hai district, Tra Vinh province, where the largest mangrove areas exist (see Figure 1). It had 5,616.09 ha of mangrove forest across the 9,538.74 ha of Tra Vinh province (Tra Vinh Provincial Sub-department of Forest Protection, 2022). The mangroves of Long Khanh commune account for 21.62% of the total mangrove areas of the district and Don Chau commune accounts for 3.07% of the total mangrove areas (Ibid.). Long Khanh commune had the largest areas of mangrove-shrimp farming, with 634 households that practised mangrove-shrimp farming in an area of 1530 ha (Tra Vinh Provincial Sub-department of Fisheries, 2022). Meanwhile, Don Chau commune,

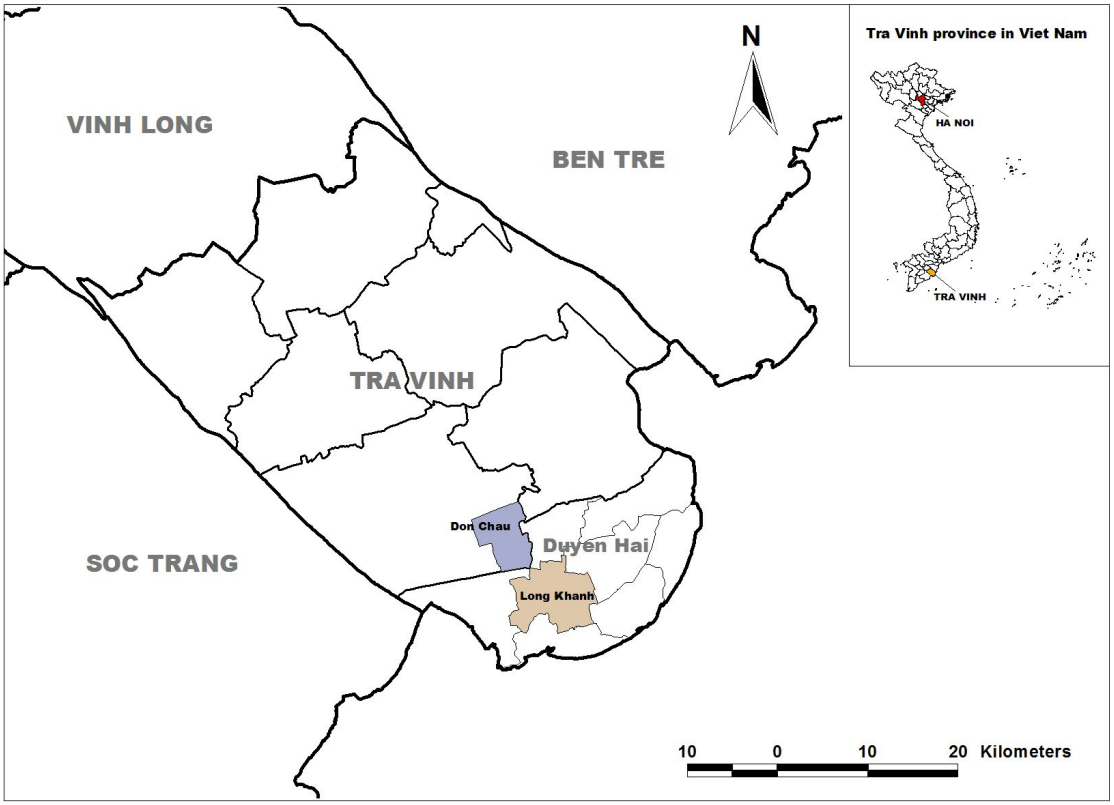

FIGURE 1. Map of Long Khanh and Don Chau commune, Duyen Hai district, Tra Vinh province.

which has the smallest mangrove areas in the district, had well-developed extensive shrimp farming. Many shrimp farmers in Don Chau commune were interested in shrimp farming with certification because they believed that by participating in the project, they would gain better and more effective shrimp farming knowledge and, more importantly, they wanted to aim for certified shrimp farming in their respective area.

2.2. Methodology

2.2.1. Approach

The research used the Knowledge- Attitude and Practice (KAP) assessment along with focus group discussions to understand perceptions, skills, and lessons learned that served as the basis for developing capacity building programs on sustainable mangrove-shrimp aquaculture in accordance with the international standards in the context of climate change for relevant stakeholders in Tra Vinh province.

KAP is a frequently used survey methodology in social research (Vandamme, 2009). The method is used to quantify and analyse human perception and behaviour relating to a certain topic in three aspects: to what extent they know about that topic, how positively or negatively they regard it, and what they would do relating to it (Kaliyaperumal, 2004). The result of the KAP survey is to identify knowledge gaps, attitudinal challenges and the factors influencing the attitudes and behaviour of stakeholders relating to certain issues (WHO, 2008).

In our study, knowledge was referred to understanding sustainable shrimp farming and their training history and lessons learned from those training on shrimp farming. The attitude of the respondents was considered to be the willingness to participate in training and activities on sustainable shrimp farming and international food standard certification - ASIC. Practice was conducted to assess whether the change in awareness and attitudes of local shrimp farmers has led to a change in the ways in which they farm shrimp towards sustainable mangrove-shrimp aquaculture at the community level.

2.2.2. Methodology

The research was organised on two levels: desk study and fieldwork.

- Desk study: We conducted a literature review on shrimp farming practices in Vietnam and certificates that have been applied and are potential for implementation in Vietnam, especially in the Mekong River delta. Socio-economic develop-

FIGURE 2. A mangrove-shrimp farming pond in Long Khanh commune, Duyen Hai district, Tra Vinh province.

ment plans of the research areas and related policies and programs on shrimp farming in the Mekong River delta were also studied.

- Fieldwork: Primary data collection was carried out through key informant interviews and focus group discussions. We conducted key informant interviews with 40 stakeholders, of whom 11 were officials of relevant departments, two were from private shrimp companies, one was an aquaculture lecturer at Tra Vinh University, and 26 were shrimp farmers in Duyen Hai district, Tra Vinh province. A questionnaire was designed to collect information on relevant stakeholders' knowledge and experience related to shrimp farming, their training history and lessons learned, their knowledge gap and training needs, and their suggestions for the training format, duration, and location. Those stakeholders included local shrimp farmers who were members of the cooperative group, policymakers, NGOs active in the region, and the private sector that was engaged in the shrimp. A focus group discussion with eight shrimp farmers was conducted in each commune. The questions covered information about current methods of shrimp farming practised by local farmers, the knowledge and skills that they had gained from previous training courses, what the gaps were and what they would need in order to better manage mangrove-shrimp aquaculture and also improve their household economy.
- Field observations in Duyen Hai district and Bac Lieu province: Field observations were employed while field research was being conducted in Long Khanh commune and Don Chau commune, Duyen Hai district, Tra Vinh province. This helped the research team better understand different methods that local shrimp farmers applied to their shrimp farming as well as the profits and impacts each method brought to local people. Furthermore, field observation was also used during the study tour to Bac Lieu province with heads of households engaged in shrimp farming from the two communes to learn good practices on shrimp farming combined with ecotourism in the study site and draw lessons that can be applied to Tra Vinh upon their return.
- Consultation and policy dialogue workshops: Thirty stakeholders who were policymakers from relevant provincial departments, small-scale shrimp farmers and shrimp private companies in Tra Vinh province participated in the consultation and policy dialogue workshops. Small-scale farmers participated in the survey on training needs on shrimp farming and attended the training courses, which were developed based on the results of the training needs assessment.

3. RESULTS AND DISCUSSION

3.1. Shrimp farming and mangrove forests in Tra Vinh province

Within 30 years, from 1988 to 2018, the area of the mangroves in Tra Vinh province had a dramatic change, decreasing by 70% (10,678.7 ha) from 15,176.2 ha to 4,497.4 ha (Son et al., 2020). The recovery rate of the mangroves in this period was nearly five times lower than the loss rate. The area of mangrove forests lost due to deforestation to construct shrimp ponds and causing coastal erosion was 13,383.7 ha, while the area of newly formed mangrove forest on newly accreted coastal lands, dunes in the river mouth area, as well as the new planting of mangroves in inefficient shrimp ponds, was 2,704.9 ha (ibid). During the time this field research was being conducted, the total area of mangrove-shrimp farming in Tra Vinh was 7,041 ha, concentrated in 5 sub-regions of Duyen Hai district and Duyen Hai town. According to Decision No. 1925/QD-UBND dated September 29, 2022, the area of 7,041 ha of mangrove forests will be maintained until 2050. As stipulated in Plan No. 69/KH-UBND dated August 6, 2021, of the Tra Vinh Provincial People's Committee, by 2030, 5,700 ha (accounting for 80.9% of the total area) of mangrove-shrimp aquaculture will be awarded ecological certification.

During the time this field research was being conducted, there were no farms with ecological certification. According to participants of the focus group discussions, the reasons are twofold. First, there was no difference between the selling price of certified and non-certified shrimp. Second, the procedure and costs to obtain certification were complicated and expensive, and every year, shrimp farmers would have to pay extra costs to evaluate and maintain the certificate. In addition, because the shrimp farming area of the households was small (about one ha/household), if organic shrimp farming was practised, shrimp production would be lower than traditional shrimp farming and, therefore, shrimp farmers' income was lower compared with traditional farming methods. It is also important to note that due to low shrimp yields, with not enough quantity of farmed shrimp needed for each sale, traders did not come to buy local farmers' shrimp. These problems explain why shrimp farmers did not want to own ecological certifications.

According to key informant interviews, mangrove-shrimp farming started 20 years ago in Tra Vinh province and shrimp farmers have been trained in mangrove-shrimp farming techniques. However, local shrimp farmers still farmed shrimp just using traditional methods (see Figure 2). The reasons include (i) the inability of the household to invest in infrastructure for farming; inappropriate infrastructure with no planning, no investment in water supply channels, no separate drainage, and lack of qualified fry, which were only enough to supply 25% of the demand, also with the quality of fry not checked by the Sub-Department of Fisheries. All of this has made local shrimp farmers more interested in traditional farming methods than sustainable mangrove-shrimp aquaculture.

Our observation while in the field showed that traditional shrimp farmers stocked shrimp with high density, used more industrial feed, took advantage of available farming ponds, and did not invest in or plant additional mangrove forest trees in the pond. As a result, the forest cover in the farming pond was way below the required standard of 40%. According to an official at the Tra Vinh Provincial Sub-department of Fisheries, because the farming area has not been planned, there is no separate water supply and drainage canals. In reality, the extensive and intensive farming ponds alternated in the same farming area, the wastewater from the intensive farming pond was the water supply of the extensive farming pond. This is the cause of disease spread, leading to high shrimp mortality keeping the economic efficiency of shrimp farming in the province low.

3.2. Training needs assessment of small-scale shrimp farmers on shrimp farming practices

Interviews were conducted with 40 representatives of the public and private sector and local shrimp farmers, of which 26 participants were small-scale shrimp farmers in Duyen Hai district, Tra Vinh province. Among these 26 farmers, three people (making up 11.5%) raised shrimp for about 30 years since the 1990s, 21 (80.7%) farmed shrimp for 20 years, while only two people farmed shrimp for the last ten years.

Figure 3 shows shrimp farming methods that small-scale farmers used in the Duyen Hai district, Tra Vinh province. The figure demonstrates that the highest percentage of farmers implemented extensive shrimpfarming[1], which accounted for 57.7% (15 people), while 23.1% of interviewees used

[1]Extensive shrimp farming: Shrimp farmed naturally, with limited additional feeding (Phuong et al., 2004) and low initial stocking densities of 1–3 post larvae per square meter (Tran et al., 2012a).

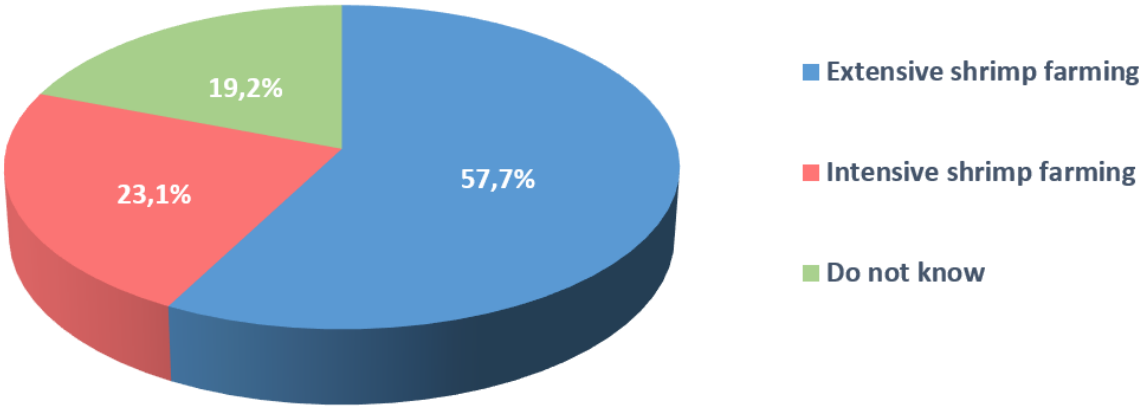

FIGURE 3. Shrimp farming methods practised by sample shrimp farmers in Duyen Hai district, Tra Vinh province in 2022.

intensive shrimp farming[2] (six people) and the remaining 19.2% did not know which methods of shrimp farming they were practising. The findings show that shrimp farmers who used natural shrimp farming methods were more interested in applying sustainable mangrove-shrimp models in their respective areas.

With regard to the level of understanding of sustainable shrimp farming, only one participant (accounting for 3.8%) could describe the benefits this method could bring from social, economic and environmental aspects, while three people (11.5%) stated the economic and environmental benefits. Meanwhile, 14 people (53.8%) explained an aspect or technique in sustainable shrimp farming and they emphasised the importance of fry standards, and 30.9% of the remaining interviewees did not know what sustainable shrimp development was.

As a high percentage of sample shrimp farmers stated that they did not know clearly about sustainable shrimp farming and they had only farmed shrimp based on their experiences, a high number of interviewees expressed their willingness to participate in training on shrimp farming. Specifically, 95% of the sample shrimp farmers' desire was to attend at least a training course related to (a) sustainable mangrove-shrimp farming techniques; (b) lessons learned on sustainable mangrove-shrimp farming, access to markets or a purchasing company engaged in sustainable mangrove-shrimp farming and already awarded ecological certification; (c) International certification in Sustainable Forest Shrimp Farming such as ASIC; and (d) a demonstration model on sustainable mangrove-shrimp farming for local application and replication in the future. The interviewees also said they wanted to have training courses that last three days each.

It is important to also note that a sustainable shrimp farming cooperative group was established in Long Thanh commune before the training courses were conducted. This demonstrated that local shrimp farmers were very much interested in new ways of farming shrimp and were eager to apply sustainable mangrove-shrimp aquaculture in accordance with international standards in their locality.

3.3. Results of training on sustainable shrimp farming

Those who participated in the training needs assessment survey were also invited to attend the training courses on sustainable mangrove-shrimp farming techniques in accordance with international standards and ASIC certification, which was customised from VietGAP (Vietnamese Good Agricultural Practices) to suit the context of Tra Vinh province was introduced to the participants. It is important to note that the Food and Agriculture Organization (FAO) has developed a set of principles called Good Agricultural Practices (GAP) that are geared towards large-scale production households/companies. GAP principles generally focus on creating safe and hygienic products that are economically, socially and environmentally sustainable. Meanwhile, ASIC aims at small-scale shrimp farmers and focuses on principles to improve sustainability, environmental and socioeconomic performance. A study tour was organised for the participants to Bac Lieu province, where there were good practices on mangrove-shrimp

[2]Intensive shrimp farming: Farmers maximize shrimp yields by applying high densities of larvae (EJF, 2003) and strictly managing water quality by preventing the connection with surrounding waterways (Joffre & Bosma, 2009).

farming combined with ecotourism. An assessment was also conducted as part of the training course. The results of the evaluation showed that all participants were interested in the training and were happy with the knowledge that they had been equipped with. They were specifically interested in the mangrove-shrimp combined with ecotourism. They all expressed their willingness to adopt those practices upon their return.

A small shrimp farmer in Duyen Hai district, Tra Vinh province, said:

> *"I realised that the knowledge and skills on mangrove-shrimp farming are very useful for us. We have raised shrimp for years with mangrove stands in the shrimp pond. However, we have not paid much attention to the roles of the mangroves. I have also learned a new model of mangrove-shrimp farming combined with ecotourism, and I think this is a good model that brings profits to farmers. I will try to apply this model upon my return."*

A staff member from a fishery company shared:

> *"Although I have known some other models of sustainable shrimp farming, I did not clearly understand their techniques. Through this training, I have gained more knowledge and skills on better shrimp management combined with ecotourism so that I can support local farmers more effectively."*

A policy dialogue workshop was conducted at the end of the study and served as a forum for policymakers to meet and discuss face-to-face with local shrimp farmers to learn about their problems/challenges as well as problem-solving. The workshop was attended by representatives of the Tra Vinh Provincial Department of Agriculture and Rural Development, Tra Vinh Provincial Agriculture and Fisheries Extension Center, the Duyen Hai District Department of Agriculture, Cuu Long SeaPro Joint Stock Company, Farmers' Association and shrimp farming households in Long Khanh and Don Chau communes.

It is important to note that heads of those shrimp farming households had already participated in the training needs assessment, the training courses and the study tour. It was reported that it was for the very first time shrimp farmers had the opportunity to meet and discuss face-to-face with policymakers about their problems related to shrimp farming. In contrast to the results of the evaluation conducted at the end of the training, almost all shrimp farmers attending the workshop said that they did not want to apply the (ASIC) international food standard, even though the representatives from Tra Vinh Sub-department of Fisheries, Tra Vinh Sub-Department of Forest Protection, and Cuu Long Seaproducts Company were committed to provide them technical support to practice ASIC and buy shrimp from those households.

According to the shrimp farmers, being fully equipped with new knowledge and skills was necessary but not yet sufficient for them to switch to ASIC since there were still too many difficulties and challenges. Many of them said that now, because shrimp disease was so serious ,they were not interested in farming shrimp anymore, despite the fact that they were provided technical training and went on a study tour. They believed that without the active participation of the local government and the private sector, the transition of shrimp farming in Tra Vinh based on the requirements of the ASIC international standard would not happen. According to the head of the Long Thanh Cooperative Group, public and private partnerships (PPP) can be particularly beneficial for the shrimp farming industry in the MRD in the following ways:

- Improved productivity: PPPs can help improve productivity in the shrimp farming industry by providing farmers with access to better technology, training and inputs. This can lead to higher yields and profits for farmers.
- Improved environmental sustainability: PPPs can help to improve the environmental sustainability of the shrimp farming industry by promoting the use of sustainable practices, such as closed-containment systems. This can help to reduce the environmental impact of shrimp farming and protect the environment.
- Increased exports: PPPs can help increase shrimp exports from Vietnam by providing farmers with access to international markets. This can boost the economy and create jobs.

The members of the Long Thanh cooperative group and the shrimp farming households of Don Chau commune also hoped that, in the near future, sustainable mangrove-shrimp aquaculture will become a reality in Tra Vinh with the participation of both the public and private sectors.

4. CONCLUSION

As the case of Tra Vinh province illustrates, moving towards sustainable mangrove-shrimp

aquaculture based on ecological/organic shrimp farming requirements in accordance with international standards is the right direction for local shrimp farmers to go. To facilitate this transition, it is crucial to employ capacity building methods tailored to the local context and culture, specifically targeting stakeholders in shrimp farming and PPPs. The findings indicate that workshops and training sessions focusing on mangroves, shrimp-forest farming techniques, ecological certification, cooperative economy and product value chains have played a role in altering perceptions within the local community, fisheries management agencies and local authorities. These sessions empowered local shrimp farmers to recognise the challenges they have faced and offered sustainable solutions. The workshops aimed to align aquaculture practices with ecological certification needs, fostering a more sustainable approach. The ultimate goal is to expand both the domestic product market and seafood exports in the future.

However, the case of Tra Vinh also demonstrates that changes in knowledge and attitudes did not lead to changes in practice. Almost all the shrimp farmers who participated in the training and the study tour did not change the ways in which they farmed shrimp to meet international food standards. This is due to the lack of partnerships between the local government and shrimp exporters that could have been an effective catalyst to facilitate the transition towards sustainable mangrove-shrimp farming in accordance with international food standards.

The research findings also show that with the knowledge and skills that local shrimp farmers have gained, they became aware of the trend of aquaculture development in the new era. It is hoped that the participation of the public and private sector will encourage them to boldly and confidently change their way of thinking and traditional farming practices towards responsible, ecologically certified aquaculture linked with chain partners to increase product value. As such, they will contribute to increasing household income while maintaining and conserving mangrove forests and reducing negative impacts caused by climate change in the near future in Tra Vinh.

Further research should be carried out in the future to provide new insights into the possibilities and constraints of PPPs in facilitating the transition towards compliance with international sustainability requirements and motivating small shrimp farmers to apply for ASIC international food standards in the region.

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