Netherlands Enterprise Agency

Kingdom of the Netherlands

REPORT

AQUACULTURE FARMER'S NEEDS IN MEKONG RIVER DELTA VIETNAM

Hanoi, January 2024

TABLE OF CONTENTS

ACRONYMS

ASC	Aquaculture Stewardship Council
BAP	Best Aquaculture Practices
EU	European Union
EVFTA	European-Vietnam Free Trade Agreement
FAO	Food and agriculture Organization of the United Nations
FCR	Feed Convert Rotation
FDI	Foreign Direct Investment.
GlobalGAP	Good Agricultural Practice
GSO	General Statististics Offfice of Vietnam
HACCP	Hazard Analysis and Critical Control Point System
MARD	Ministry of Agriculture and Rural Development.
DFISH	Directorate of Fisheries
DARD	Department of Agriculture and Rural Development.
RIA.1	Research Institue for Aquaculture No1
ICAFIS	International Collaborating Centre for Aquaculture and Fisheries Sustainability
MRD	Mekong River Delta
RAS	Recirculating Aquaculture System
SUSV	Sustainable and Equitable Production and Value Chain Development in Vietnam
VASEP	Vietnam Association of Seafood Exporters and Producers
VietGAP	Vietnamese Good Agricultural Practices
VIFEP	Vietnam Institue Fisheries Economics and Planning
VINAFIS	Vietnam Fisheries Society
WB	World Bank
WWF	World Wide Fund For Nature

LIST OF TABLES

LIST OF FIGURES

FOREWORD

It is with pleasure that we present to you the assessment report "Aquaculture farmer's needs in Mekong River Delta, Viet Nam". The report is commissioned by the Agricultural department, Netherlands Embassy in Hanoi and the Netherlands Enterprise Agency to explore the insights into the needs, challenges and aspirations of the farmers engaged in shrimp and pangasius of the aquaculture sector.

Viet Nam's aquaculture industry, particularly in the Mekong Delta, plays a critical role in the aquaculture supply chain and in the economy of the country. As we navigate an era of evolving environmental dynamics, market demands, and technological advancements, it becomes imperative to prioritize the needs and challenges faced by the backbone of this industry – the farmers.

The Mekong Delta presents a unique set of challenges and opportunities for aquaculture. Through the lens of this report, we aim to shed light on the hurdles faced by farmers, as well as factors influencing their decision-making process towards a more sustainable and prosperous future.

The report not only identifies challenges but also makes efforts in uncovering collaborative possibilities. By recognizing the interdependence of stakeholders – farmers, policymakers, industry players, and researchers – we set the stage for a collective effort to enhance the involvement of farmers in the sustainable aquaculture supply chain.

We see this report more than a compilation of findings; it implies a call for action to bring farmers, industry, and knowledge closer. It urges all stakeholders to engage with the insights presented, fostering dialogue, innovation, and collaborative initiatives that uplift the resilience and efficiency of the sector.

Our sincere gratitude goes to the dedicated team of Agriterra and ICAFIS for their diligence and expertise in this study. Additionally, our appreciation goes to the farmers who generously shared their experiences, enriching this report with authentic narratives.

Thank you and we hope you enjoy reading.

Ingrid Korving

Agricultural counselor

Royal Netherlands Embassy in Vietnam

SUMMARY

The Mekong River Delta (MRD) in Vietnam is widely recognized as the most productive region for brackish and freshwater aquaculture and fisheries due to its favorable environmental conditions, vast water surface area, and abundant fishery resources. However, Vietnam's Aquaculture sector is seen as going through significant challenges leading to immediate negative effects on smallholder farmers that need to and can, be addressed with Dutch expertise. In line with this strategy, midweek of August marked the first-ever milestone Agriterra commenced to dive into the Aquaculture sector in Vietnam following the Dutch Embassy and The Netherlands Enterprise Agency (RVO) initiated their support to finance a Needs Assessment mission over aquaculture smallholder farmers in the Mekong River Delta to look specifically into the situation, which involves farmers' challenges to be tackled along with various potential opportunities to be seized, towards materializing support strategy in the time ahead.

The mission - which was carried out by a joint effort of the Agriterra team and ICAFIS with strong collaboration of aquaculture and Dutch businesses, local stakeholders, shrimp and pangasius smallholder farmers in MRD and 04 selected provinces – was aimed at gaining a comprehensive understanding of the aquaculture farmers' challenges and identify their specific needs towards ultimately arriving at uncovering potential opportunities for enhanced involvement of farmers in sustainable aquaculture production supply chains. The assessment scope involves 04 MRD provinces (Can Tho, Vinh Long, Ca Mau, Bac Lieu), which are reported as the top leading aquaculture production areas in Vietnam, covering the improvements in water quality and efficiency, reducing disease-related expenses in fish farming, minimizing the use of antibiotics, fostering technological innovation, establishing mangrove forests, and implementing a stratification process for agriculture. The participatory approach with different methodologies and tools were used for this assessment, including desk research, online interviews, field study, in-depth interviews, structured-questionnaire interview, focal group discussion, etc. where key selected small-scale producers, sector experts, local authorities, traders/dealers, input/service providers and related stakeholders were involved. To come up with the most reliable deliverables, the research concentrated on learning 06 key areas/research questions such as (i) Fragmented production with poor quality and productivity of aquaculture farmers; (ii) Limited access to quality inputs; (iii) Insufficient access to innovative and affordable technologies; (iv) Lack of access to finance; (v) Limited skills and capacity to adopt good aquaculture practices; and, (vi) The relatively low level of engagement of small farmers in sustainable supply chains.

As a result, key findings over both sectors - shrimp and fish pangasius – were identified afterwards, laying a concrete foundation for several substantial conclusions as the following.

Shrimp sub-sector

Fragmented production – An urgent need for re-organizing farm-level production

Assessment results showed that the average farm size per household (HH) for the 2022 shrimp farming was 2.62 ha. **Most of the farms below 3ha account for up to 85% while the rest, whose size is over 3ha, make up less than 15% and belong to companies and a few HHs**. Another important issue pointed out was of the **labor force as data collected represented a weak abundance in labor market in the region** – the average per HH was recorded as only 4.5 of which 2.1 take their part in shrimp farming. This demonstrated the likelihood of a high potential shortage of this force for the sector.

HH's shrimp farming-sourced income is also a crucial perspective that was studied which averages VND 195 million per year.

A steady increase in investment costs – An urgent need for cost reduction

The assessment results also showed the financial capital and investment structure that shrimp farmers need for their farming. In 2022, **the average investment cost/ha/household was VND 179 million,** this would mean the total investment/HH is VND 470 million/harvest (2.62 ha/HH on average). Assessment analysis proved that of the total investment, **Variable costs accounted for 99%, including Feed (57%), Seeds (20%), drugs and chemicals (7%),** electricity (5%), Sludge collection (4%), Labor (3%) and bank interest rates (2%). Feed and seed costs have been increasing over the last 5 years due to upward prices of input materials for feed production.

There is a substantial difference in investment costs between the intensive and ecological farming models (intensive shrimp farming: 396 million VND/ha/year, the ecological shrimp: 12 million VND/ha/harvest). **The average profit margin is 27%,** of which the highest profit ratio is from the ecological shrimp (66%), intensive shrimp reaches the lowest profit (21%), then comes the semi-intensive (34%).

Feed and seed costs are dominant – A need for a switch toward more efficient farming.

The survey found that farmers' access to seed remained problematic as the **survival rate was reported as low which is about 15% for the ecological shrimp, and about 50-55% for semi-intensive and intensive shrimp models**. In particular, 100% of HHs bought shrimp quality-certified seeds from local dealers and companies in the production area. Besides, the intensive farming model has proved to be more efficient, both economically and environmentally as it requires better water management techniques by which shrimp is more survived and FRC is also improved. All HHs, **both intensive and semi-intensive farming, used industrial feed purchased from local feed agents, and an average of FRC was calculated as 1.49**, in which FCR from intensive shrimp farms is 1.48 which is slightly lower than that from semi-intensive shrimp farming - 1,51.

A modest investment in technology – Removing barriers to knowledge and technical capacity.

There is a high demand for new technological applications among shrimp farms in the Mekong Delta. For the ecological shrimps, technologies have not been adopted as widely as the intensive and semi-intensive shrimp farms have.

There is a need for both intensive and semi-intensive shrimp farming households to embed technologies into multiple aspects, including water treatment (30%), biological products to improve shrimp health (30%), sterilization (20%), and antibacterial (20%), disease prevention and treatment technology (20%), gas and oxygen supplementation (15%), pond smart management (12%), food (10%), closed farming (10%), among others such as waste management, sludge settlement, feeding, harvesting.

Limited access to bank loans – High need for access to preferred loans from banks and credit from the company

The household's average investment capital needs for shrimp farming were 470 million VND/harvest. At the assessment in 2022, the investment capital comes from 02 sources (i) households' capital, accounting for 43%; (ii) bank loans, accounting for 57%.

Current bank loans only meet 40% of the investment needs of households, especially for intensive farming households. The banks that provide credit mainly to farmers are state-owned banks including **Agribank and ViettinBank**. Most of shrimp farming households borrow using land title as collateral to secure a loan from state banks, so the interest rates are normally lower compared to households borrowing for pangasius farming.

A big gap in business management training – A need for more skills in business management.

Farmers gained strong access to technical training, 83% of farmers have attended at least one training course on shrimp farming techniques. **Of all models, intensive farming was in a dominant position in farmers' access to technical training (95%)**. Farming households had a great need for access to information and techniques, popular topics include i) **Apply sustainability standards (82%);** (ii) Disease management (68%); (iii) Climate change adaptation (64%); (iv) Quality control of input products (41%); (v) Effective feeding management (31%); (vi) Advanced techniques (29%); (vii) New technologies (20%). Nonetheless, **most farmers have never participated in any training courses on developing business plans and financial management in shrimp production**.

Unstable sourcing model – A need for shortening the value chain with more collaboration.

The proportion of smallholder farmers who reached processing companies was minor. Assessment indicated an average of **only 7% of households have direct contracts with processors while the rest 93% of farmers sold shrimp to traders and wholesalers in the province. The number of raw materials from the company's production areas satisfied about 14.6% of the total raw material demand**.

Pangasius sub-sector

Smallholder farms exposed to high risk and dropped – A need to improve scale and production efficiency.

The average production area per household (HH) in 2022 was 3.14 ha, 325 tons/ha/harvest. The area of small-scale HHs only accounted for 20-30% of the total area, mainly concentrated in provinces such as Vinh Long, Can Tho, Tien Giang, and Hau Giang. **The average size of a pangasius farming HH was 4.2 people/HH.** The number of workers per household participating in pangasius was 1.7 people. **The 2022 average profit per HH of surveyed was VND 1,042 million**. Nonetheless, there was a need for a huge investment capital averaging 26.96 billion/year, and the **profitability rate is only 4%/10 months or about 5%/year.**

Huge investment required to pangasius – An urgent need to prune the costs.

The average investment cost /household was 8.56 billion VND/ha/harvest, so each HH needs 26.96 billion VND/harvest for their average area of 3.14ha. Investment structure: **Fixed costs (1%); Variable costs (99 %)** (including **(i) Feed (84%) (ii) Seed (8%); (iii) Drug and chemicals (3%) and (iv) Bank loan interest was 2%).**

Feed cost was the dominant factor of HH. Currently, most of the ingredients for pangasius feed are imported, and prices have increased due to fluctuations in the world markets, causing the selling price of pangasius feed to continuously increase

Feed and seed costs are dominant costs – A need to switch towards a more efficient farm.

Access to seed: 100% HH bought fingerings from local seed production households without quality certification. The survival rate of surveyed farming was only about 52%, a big drop compared to in the previous years (about 62% in 2019) and even 90% in some years.

Access to feed: 100% of HHs used industrial feed purchased from local agents. Currently, the FCR in pangasius farming tends to increase to 1.7-1.8 compared to in the past (1.2-1.4).

Access to drugs and chemicals: 91% of farmers bought drugs and chemicals at local agents; 53% bought on deferred payment. 50 - 60% farmer used drugs and chemicals empirically. By 2022, over 500 supplier companies provide drug and chemical to farmers.

Bounded investment in technology – More incentives and education for technology adoption

Technology in the pangasius farming industry is less diverse and innovative than that in shrimp farming. Among all aspects, the proportion of new feed-related technologies is 50%, wastewater sludge management is 27%, followed by disease prevention and treatment technology (16%), and biological products to improve the environment, farming environment and fish health (16%), disinfection technology (11%), and water treatment technology (11%). **Keys incentive for farmers (i) Know-how on technology (45%; (ii) Investment capacity (35%) and (iii) Technical capacity (25%).**

Limited access to bank loans – High need for access to preferred loans from banks and credit from the company

Current bank loans only met 45% of the HH's total investment needs and were mainly provided by state-owned banks (Agribank and ViettinBank). Pangasius HHs often access bank loans with higher interest rates than normal mortgages. In addition, local agents also pre-financed farmers, **about 81.8% of feed costs that are paid by households in the form of deferred payments to agents.**

A big gap in business management training – A need for more skills in business management.

Strong access to technical training: 86% of farmers participated in at least one training course with main training topics including(i) Disease management (86%); (ii) Effective feeding management (80%); (iii) Applying sustainability standards (75%); (iv) Control quality of input (60%); (v) Adapt to climate change (45%); (vi) Market information (43%). Nevertheless, **no farmer had ever access to training on business plans and financial management.**

Smallholder farmers were positioned lowest in negotiation power of the value chain – A need to strengthen the collaboration.

The assessment indicates that pangasius farming sector remains problematic due to its lack of cooperations among farmers, cooperatives, and processing facilities; 82% of small-scale pangasius farming households said they did not participate in any local collaborative groups or cooperatives.

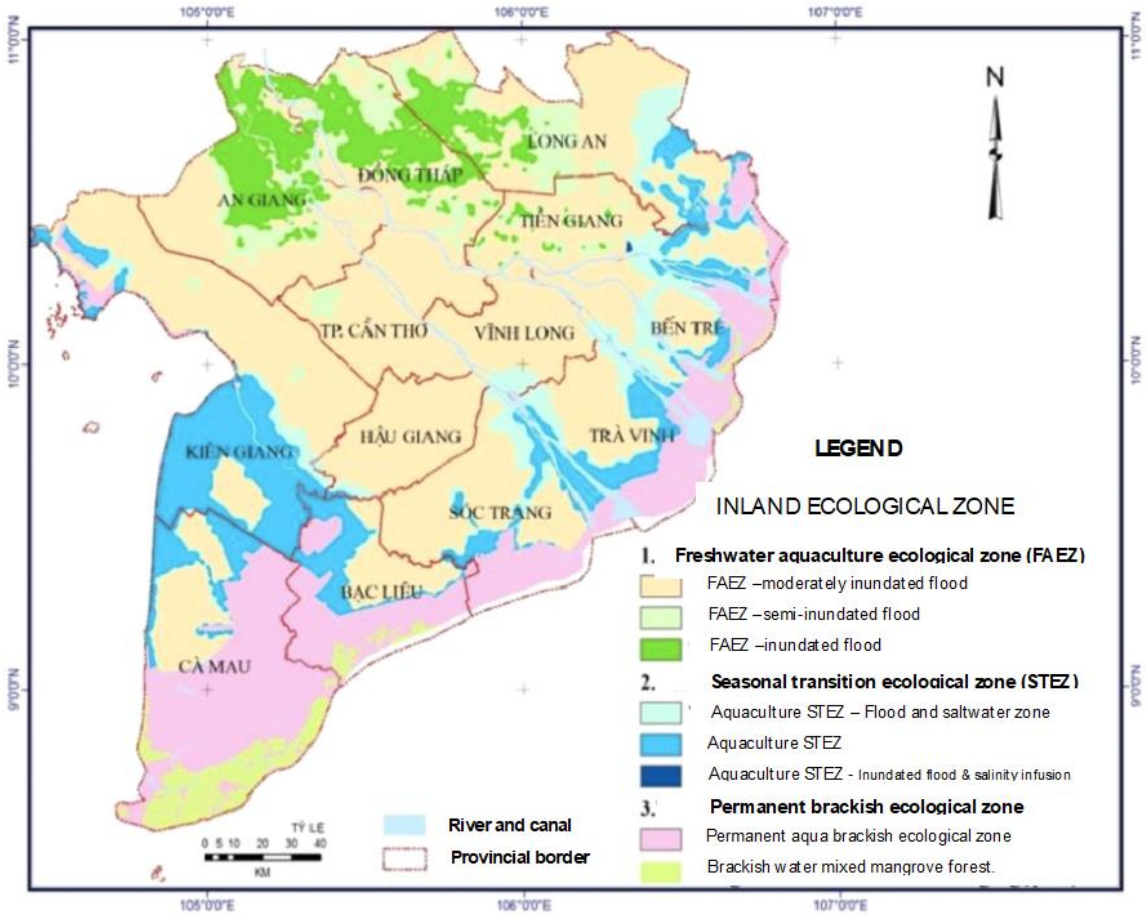
Processing companies have built raw material areas accounting for 65-70% of the company's output needs. Processing companies only sourced 30 - 35% input material from farming households in the form of signing direct purchase contracts when the fish reached the required size.

PART 1: INTRODUCTION

1.1. NATURAL, SOCIO-ECONOMIC SITUATION

The Mekong delta is located adjacent to the Southeast region, the North borders Cambodia, the Southwest borders the Gulf of Thailand and the Southeast borders the East Sea. The Mekong delta includes **12 provinces and 01 city**: Long An, Tien Giang, Vinh Long, Ben Tre, Dong Thap, Tra Vinh, Hau Giang, Bac Lieu, Soc Trang, An Giang, Kien Giang, Ca Mau provinces and Can Tho City. The delta has a natural area of about 39,747 km^2, an exclusive economic ocean zone of about 360,000 km^2, with hundreds of large and small islands belonging to two key fishing grounds in the East and Southwest. **The entire region has about 750 km of coastline with 22 estuaries and creeks and more than 800,000 hectares of tidal flats, of which 70-80% are high tidal flats**. The natural conditions of the Mekong delta create many large wetlands with diverse ecological environments (salty, brackish, fresh water), favorable for the development of a diversed aquaculture sector, and a seafood processing cluster.

Figure 01: Map of aquaculture ecological zone in the Mekong Delta



Source: Directorate of Fisheries, 2022

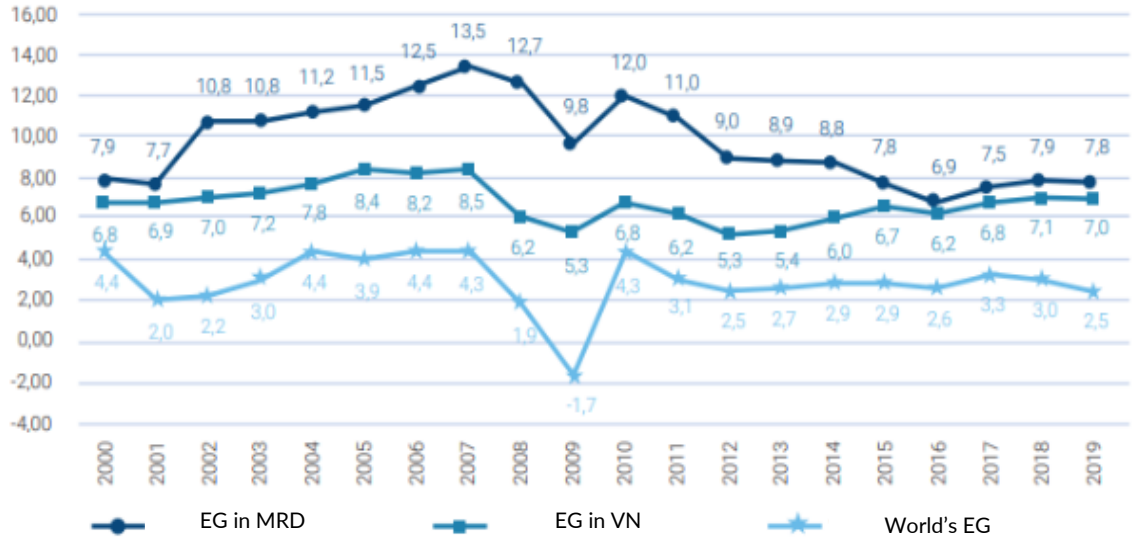
The Mekong delta is located in a tropical monsoon region, with a hot and humid weather all year round, stable high temperature, high sunshine hours and rain divided into two distinct seasons. The hydrological regime of the Mekong delta is directly affected by the upstream flow, tidal regime of the East Sea, and partly by tidal regime in the Gulf of Thailand.

The Mekong delta has a dense system of rivers and canals, including natural and man-made river systems such as the Tien River system, Hau River, Vam Co River, Cai Lon River, Cai Be River, and Giang Thanh River.

The canal system in the Mekong delta has been developed more than a century to for agriculture production and waterway transportation. Up to now, the canal system has been woven thickly at all three levels: main canal/level 1 canal, level 2 canal and level 3 canal/inner field.

According to the "*2020 Mekong Delta Annual Economic Report*" conducted by the Vietnam Chamber of Commerce and Industry and the Fulbright School of Public Policy and Management, in the period 2010 - 2019, the Mekong delta had a strong shift in its economic structure. The proportion of sector I (agriculture) in GDP structure decreased from 39.6% in 2010 to 28.3% in 2019; Region II (industry) increased from 25.7% in 2010 to 26.4% in 2019; Region III (service) increased from 34.6% in 2010 to 44.6% in 2019. The labor in the Mekong delta has shifted strongly from agriculture to industry and services; In 2010, 62.2% of workers in the Mekong delta had been in agriculture, but by 2019 this proportion was only 43.3%. Labor productivity of (I) agriculture - forestry - fishery and (III) trade - services increased rapidly in the period 2010 - 2019 by 5.2% and 8.3%, respectively; Meanwhile, the labor productivity growth rate of the industry-construction sector (II) is only 3.5%/year.

Figure 02: Economic growth rate in the Mekong Delta V.S. Vietnam and the World



Source: World Bank, GSO and local provinces, 2020

With the advantage of being blessed by natural and labor resources; **The Mekong delta is the main production region of rice, fruit, and seafood in Vietnam, contributing 50% of rice volume, 95% of export rice turn-over, 70% of fruit output of all kinds, 65% of aquaculture output, and 60% of Vietnamese seafood exports.** The Mekong delta's export turnover tends to increase and always has a trade surplus, but the region's export proportion to the whole country is gradually decreasing. During the period 2010 - 2018, the Mekong delta's exports growing rate was on average at 11.8%/year, while the national average was 16.4%/year. The reason is that the region's traditional agricultural products (rice, seafood) have low value and are reaching saturation state in turnover and decline in output due to climate change effects, as well as limited agricultural processing industry.

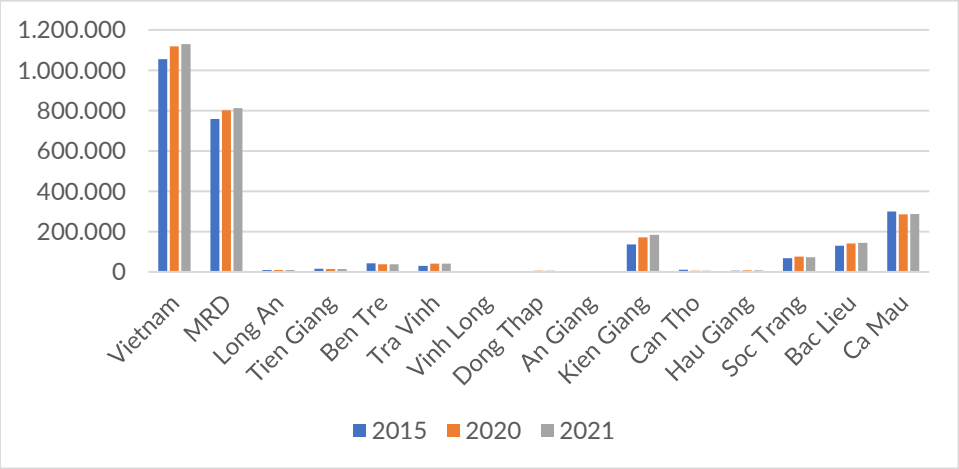
Regarding business enabling environment, the Mekong delta have improved their business environment as evidenced in its Provincial Competitiveness Index (PCI). During the period 2009 - 2018, the number of businesses/enterprises in the Mekong delta has increased; However, the growth rate was lower than the national rate.

The Mekong delta has succeeded in eliminating hunger and reducing poverty, but people's living standards are still lower than the national average. As of 2018, the rate of poor households in the Mekong delta is 5.2% according to the Government's poverty standard and 5.8% according to the multidimensional poverty standard. The Mekong delta's GDP per capita is about 80% of the national average and the gap is widening. The net out-migration from the **Mekong delta in the past decade was nearly 1.1 million people**. The quality of education does not keep up with other regions in Vietnam. The Mekong delta is currently also a "low-lying area" of urbanization in Vietnam. The urbanization rate of the whole region in the period 2009 - 2019 only increased slightly from 22.8% to 25.1%. Investment resources for the Mekong delta in the past ten years have been very low and not commensurate with the region's socio-economic development needs. The Mekong delta has advantages in waterway transportation, but is currently divided by irrigation works and the river bed is not dredged. Irrigation projects successfully help prevent saltwater intrusion to increase rice production, but they are detrimental to agricultural restructuring and its sustainable development due to their impact on environment. Besides, exports from the delta are mainly transported to Ho Chi Minh city or Ba Ria - Vung Tau, and the regional transport network has not been completed. Therefore, the delta needs more investments in transport infrastructure.

1.2. AQUACULTURE SECTOR

The total area suitable for aquaculture in the Mekong delta is over 1.2 million hectares, of which the area capable of aquaculture in tidal areas is about 750,300 hectares, accounting for over 26% of the total natural land area in coastal provinces of the Mekong delta, and equivalent to 74% of the total tidal area suitable for aquaculture nationwide. With natural advantages, aquaculture in the Mekong delta has developed strongly, contributing more than 65% of national output and about 60% of seafood export turnover. Brackishwater shrimp and pangasius are two main aquaculture and export species in the Mekong delta. In addition, the Mekong delta also develops other species such as marine fish, mollusks, and other aquatic species *(Details shows at table 1 in annex).*

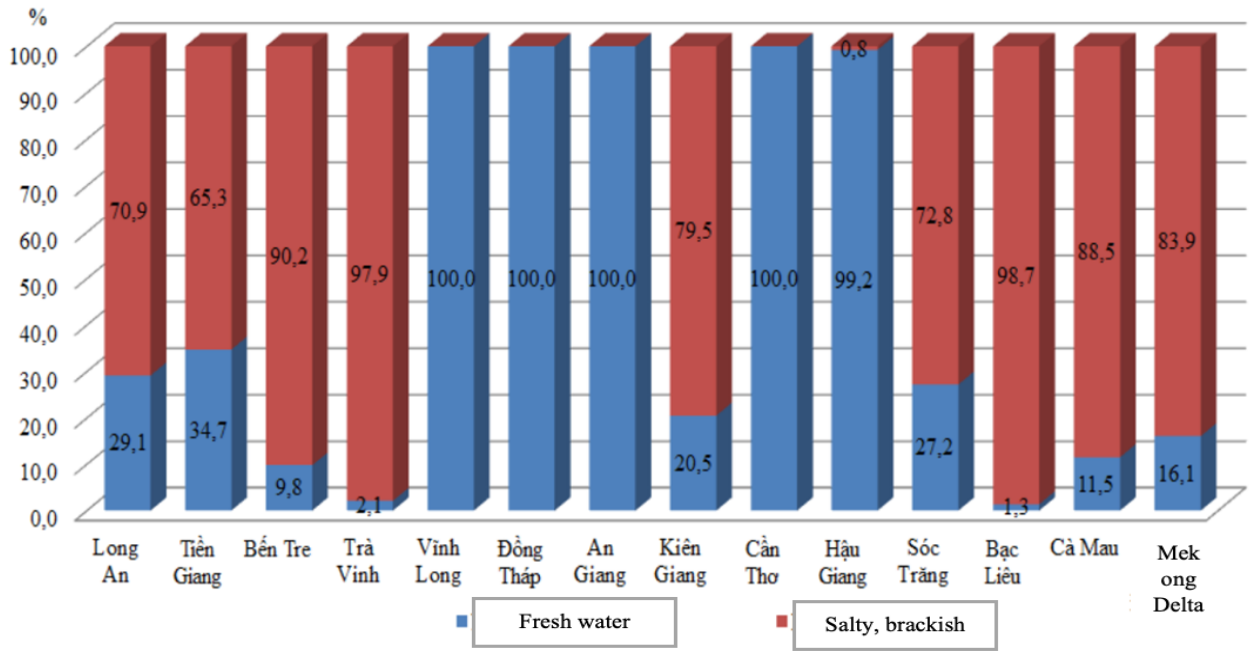
Figure 03: Aquaculture area in the MRD from 2015 to 2021



Source: MRD's Department of Fisheries, 2022

According to the General Statistics Office, **in 2022 the entire Mekong delta produced 4.86 million tons, accounting for 69.6% of the total national aquaculture output**. Of which, aquaculture output is **concentrated mainly in 5 provinces: Dong Thap accounts for 16.8%, An Giang 15%, Ca Mau 10.9%, Kien Giang 8.4%, Bac Lieu 8%, and Ben Tre 8.3%,** the remaining provinces account for 32.5% of the total national aquaculture output.

Figure 04: Structure of aquaculture areas in MRD 2021



Source: Department of Fisheries of provinces, 2021

However, aquaculture in the **Mekong delta is currently facing many major challenges** such as increasing environmental pollution, unstable consumer markets and low production efficiency due to **small-scale production and high input costs, weak market linkages, underdeveloped value chain**, and especially the effects of climate change and sea level rise. Recent studies show that climate change, combined with the shortage of freshwater due to economic development activities in the upstream of the Mekong River, has been causing drought and serious saltwater intrusion, and ecosystem changes, greatly affecting agriculture and aquaculture in the Mekong delta. **Typically, two periods of saltwater intrusion in the dry season in 2015-2016 and 2019-2020 caused great damage to agricultural production and aquaculture.** The Mekong delta has made some changes to adapt to climate change. However, this transformation is not economically, socially, and environmentally sustainable. **Lack of solid and comprehensive scientific justifications and basis on climate adaptation**, resource use efficiency, market operation, institutional organization, and cost-benefit optimization at the regional level.

1.2.1. Shrimp industry

Brackishwater shrimp, including black tiger shrimp (*P. monodon*) and white-legged shrimp (*L. vannamei*), are Vietnam's main aquaculture export.

For nearly two decades, with the policy of promoting economic restructuring and agricultural product consumption (Resolution 09/2000/NQ-CP), Vietnamese seafood exports has exploded. Especially

after the success in artificial shrimp seed production technology, Vietnam's brackishwater shrimp farming has growth strongly in both farming area and output. With the advantage of natural conditions, the **Mekong delta is a key region for brackishwater shrimp farming in the country, accounting for over 90% of cultivating area and 80% of the output, respectively**. The region's brackishwater shrimp farming is distributed along 8 coastal provinces with a diversity of shrimp farming models such as monocultured shrimp farming, such as improved extensive farming, semi-intensive and intensive farming and recently super-intensive farming models; or combined/polyculture shrimp farming, such as shrimp-rice and shrimp-forest models. The development of brackishwater shrimp farming in the Mekong delta has contributed to the transformation of the agricultural economic structure in the Mekong delta, and created jobs for over 1.35 million local people in coastal areas (DFISH, 2015). **According to statistics, the export turnover of brackishwater shrimp nationwide in 2022 was 4.3 billion USD, of which the Mekong delta accounts for over 90% (DFISH, 2022).**

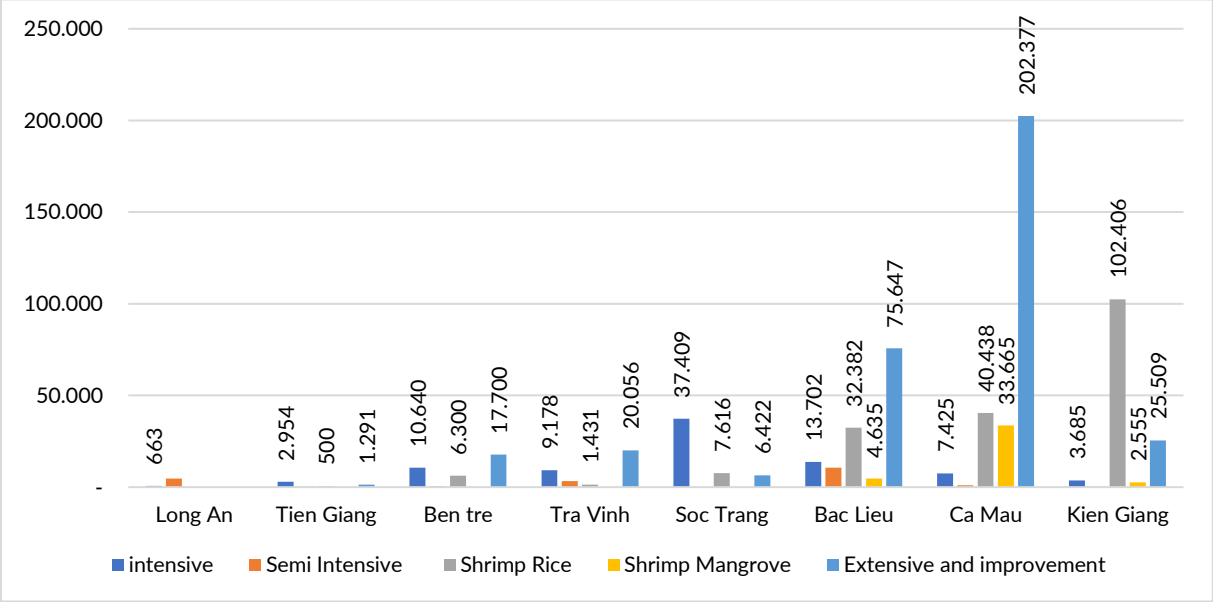
However, the rapid and "hot" development of brackish water shrimp farming, especially high-density farming of White-legged shrimp in the period 2010 - 2014 and 2016 - 2022, has revealed many shortcomings. The **spontaneous and rapid development of intensive shrimp farming** was lack of planning on production infrastructure, seed supplying sources and shrimp feed production, etc. leading to problems such as shrimp disease, water pollution, and environmental degradation in shrimp farming areas. Most shrimp farming areas do not have a centralized wastewater and sludge collection and treatment systems. **Wastewater from shrimp farming and processing carries a large amount of nitrogen (N), phosphorus (P) and other nutrients, causing eutrophication and bacterial bloom in surrounding environments. Wastewater is often discharged directly into canals and causing water pollution in shrimp farming areas.** This is the main cause of environmental pollution, leading to increased disease, reduced biodiversity and greatly affected production efficiency (Thuy and Ford, 2010; RIA.1 2013; VIFEP, 2015, ICAFIS, 2022). Research shows that from 48.0 - 87.3% and 75.0 - 94.0% of Phosphorus (P) fed into shrimp ponds are not absorbed by shrimp to create shrimp biomass but is excreted into water and released into environment through water exchange, discharge of water after harvest, and deposition in pond bottom mud. Thus, raising each ton of shrimp will release about 16.8 - 157.2 kg of N and 2.3 - 45.9 kg of P into the environment depending on the type of feed and the level of farming intensity (RIA.1 2013).

In the shrimp industry, the linkages and ccollaborative relationships among actors in the shrimp value chain are loosing and fragmented, and ineffective, that are negatively affecting product quality and traceability, and reducing the competitiveness of Vietnamese shrimp products (CBI, 2013; Nguyen Van Loc et al., 2015; Nguyen Phu Son et al., 2016). In addition, **limited access to financial resources is also a barrier for shrimp farmers**, as well as small-scale processors to expand production and to comply with required production standards from import markets. Increasing climate change's impacts in recent years is also a significant challenge, threatening the sustainable development of shrimp farming in the Mekong delta (Lam Ngoc Chau et al., 2013).

In term of shrimp species, **black tiger shrimp (*P. monodon*) farming area accounts for over 90% of the total brackishwater shrimp farming area in the delta** (559,222 hectares), concentrated in 3 provinces: Ca Mau (261,715.90 hectares), Bac Lieu (121,910.40 hectares), and Kien Giang (98,982.29 hectares). Black tiger shrimp are raised in a variety of farming models such as improved extensive farming, semi-intensive farming, intensive farming, and combined/polyculture farming (shrimp-rice, shrimp-mangrove).

Nguyen Phu Son and colleagues (2016) show that in Ca Mau, black tiger shrimp are raised in more diversed farming models such as improved extensive farming (71%), improved monoculture semi-intensive model (11.2%), shrimp-rice model (10.8%), shrimp - mangrove model (5%), industrial intensive model (3%). In Bac Lieu province, black tiger shrimp farming models are intensive or semi-intensive accounted for 11.2%, improved extensive model 0.5%, shrimp-rice model 28.1%, and polyculture shrimp model with crab, fish 66.5%.

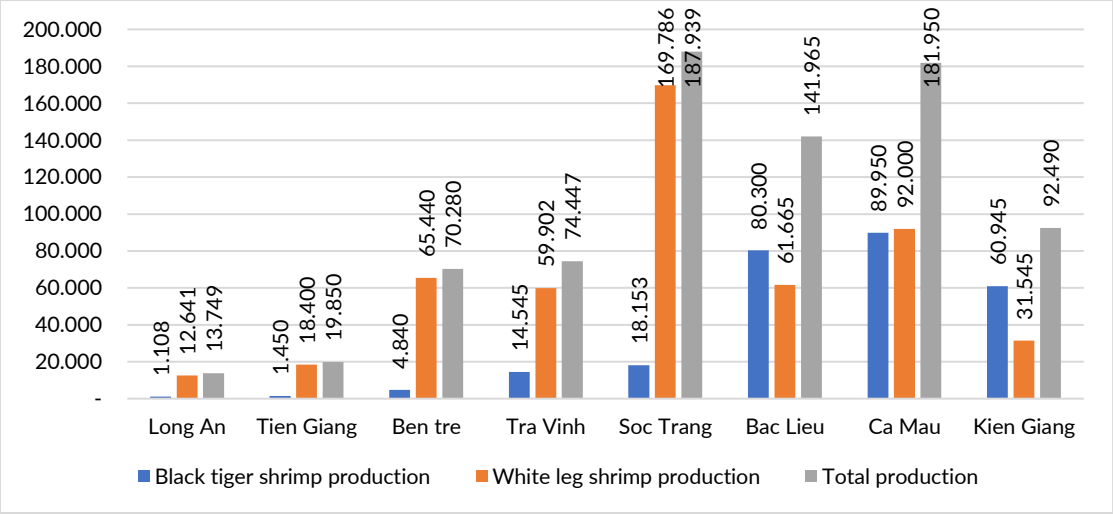
Figure 05: Brackishwater shrimp farming area in the Mekong Delta 2020



Source: MARD, DARD provinces, 2021

White-legged shrimp (*L. vannamei*) has only been introduced to Vietnam since 2001 and raised mainly in semi-intensive or intensive farming models. However, white-legged shrimp farming has only been officially allowed in the Mekong delta since 2008 and has developed very rapidly. Up to the present, this species is raised mostly in Soc Trang province 40.8%, followed by Ben Tre 13%, Ca Mau 10.8%, and Bac Lieu 10.2%. Particularly, **in Soc Trang province, white-legged shrimp farming areas are strongly expanded in replacing farming area of black tiger shrimp**. The switching trend to white-legged shrimp farming is increasing rapidly, and white-legged shrimp production in the Mekong delta is expected to increase sharply in the near future.

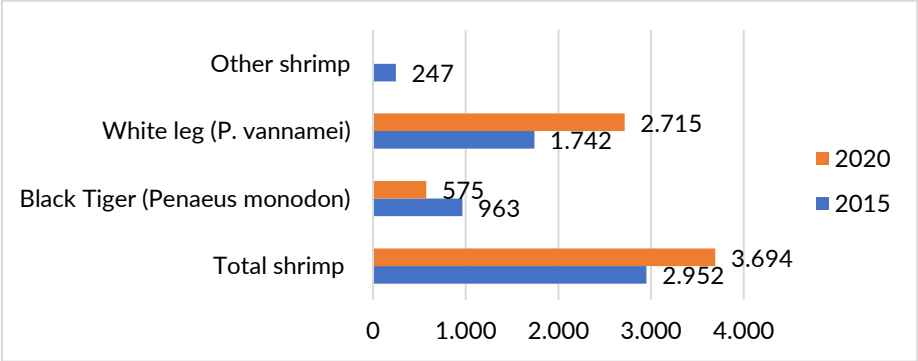
Figure 06: Brackishwater shrimp farming output in the Mekong Delta 2020



Source: Directorate of Fisheries, 2021

The market for **Mekong delta's shrimp is mainly the foreign markets in the product forms of live/fresh/frozen shrimp, accounting for 83% of shrimp production** (Le Xuan Sinh et al., 2011). In recent years, shrimp products have been processed into value-added products, such as breaded shrimp, Nobashi shrimp, Sushi, Tempura, etc. to serve the market demand, and to increase the competitiveness and profitability of the sector.

Figure 07: Vietnam's shrimp export values, 2015-2020 by shrimp species (Value: 1,000 USD)



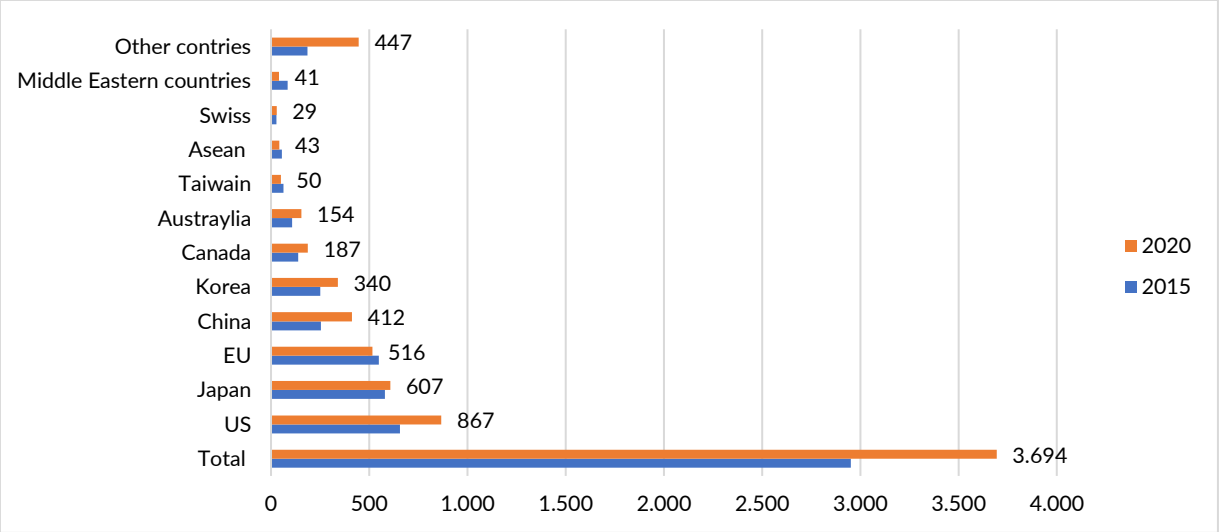
Source: VASEP 2020

In 2022, total shrimp exports value reach 4.2 billion USD. Vietnam's three largest shrimp export markets are the **US, Japan, and the EU**, but shrimp exports to these three markets are trending down and Vietnam's shrimp is **competing fiercely in aforementioned 3 markets with its competitors. Ecuador, India and Indonesia** are Vietnamese shrimp competitors in the US and Japanese markets. Thailand is a competitor in the US market. Ecuador is the main competitor in the EU market *(Details in table 2 in annex).*

The structure of Vietnam's shrimp processing products is not reasonable with mainly pre-processed forms, and so added-value products are low. Vietnamese shrimp products are considered as low quality, lacking competitiveness. Therefore, Vietnamese shrimp prices are often 5-10% lower than similar shrimp products from other countries in the region.

At the same time, **Vietnam's shrimp production costs are currently 10-30% higher than its competing countries** due to its dependence on imported shrimp-feeding ingredients such as fishmeal, fish oil, and soybeans up to 60%.

Figure 08: Vietnam's shrimp export values, 2015-2020 by markets (Value: 1,000 USD)



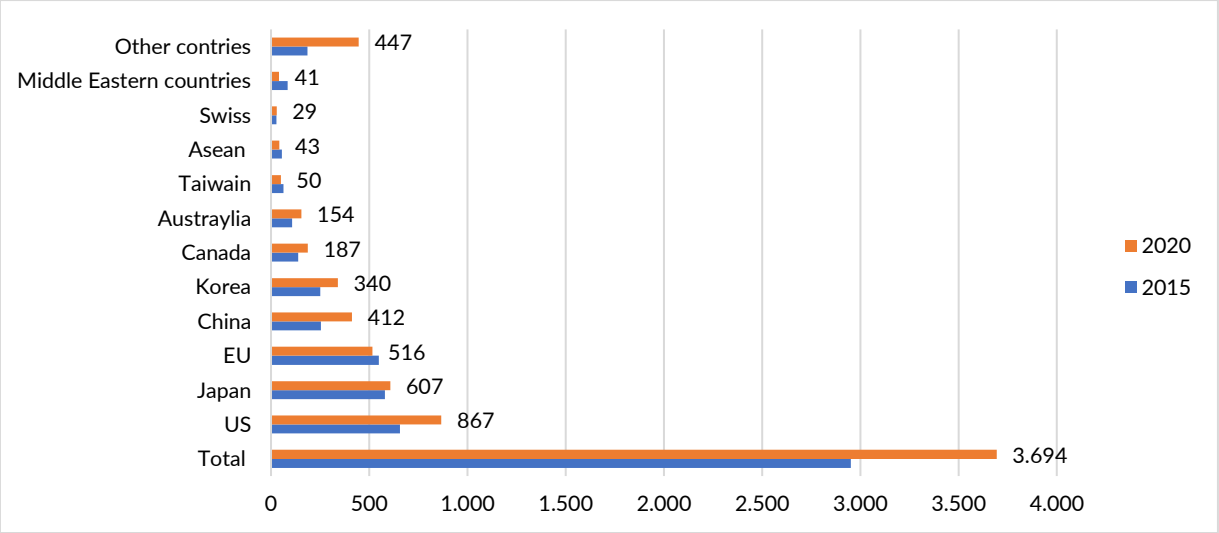
Source: VASEP 2020

1.2.2. Pangasius industry

Pangasius and basa fish have been farmed in the Mekong delta since the 60s of the last century. However, the pangasius export processing industry has only developed recently since 2002 after the sector was proactively adopting industrial breeding and farming technologies. The rapid development of pangasius industry was due to the fact that pangasius products have met consumers' needs in foreign markets in terms of food safety standards with more competitive prices than other white-fish products. **The Mekong delta is the place that supplies almost 100% of Vietnam's pangasius** raw materials, in which pangasius is concentrated along the Tien and Hau rivers. Dong Thap and An Giang are the two provinces with the largest farming area and production output in the region.

The period 2007 - 2009 was an outstanding growing period for the pangasius industry, with an average output growth of 47.8%/year. Profits from pangasius farming during this period were large, hence households rushing to stocked pangasius massively, leading to oversupply, and pangasius prices in the Mekong delta fell low at the end of 2010 and 2011. As e result, many pangasius farmers have abandoned their farming and caused pangasius farming area and output to decrease sharply in 2012-2013 from over 6,000 hectares to about 5,000 hectares in 2013; Output dropped from 1.8 million tons in 2008 to 977 thousand tons in 2013.

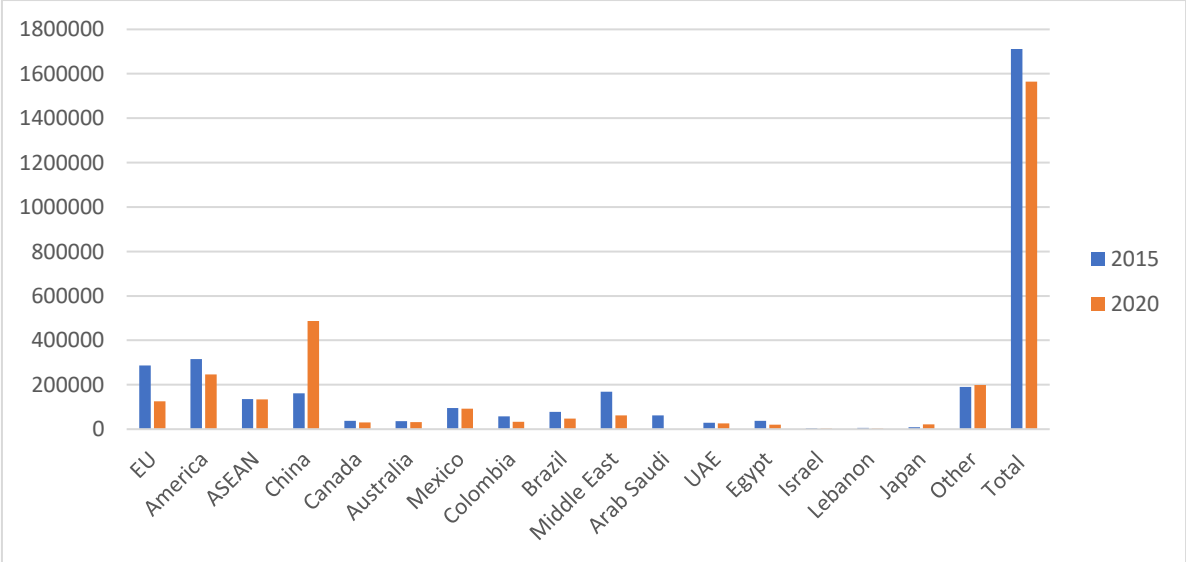
Figure 09: Pangasius farming area, volume and export turnover, 2008-2022



Source: Directorate of Fisheries VASEP, 2008 - 2022

In the period of 2014 - 2022, pangasius farming stabilized with an area of 5,300 - 6,077 hectares and an output of 1.1 - 1.5 million tons. In particular, the price of pangasius peaked at 31,500 VND/kg in 2017, and the farming area of pangasius has increased sharply from 5,548 hectares in 2016 to 6.07 hectares in 2017, accordingly. From the fourth quarter of 2022 until the present (Oct. 2023), due to the impact of the economic recession of the global economy, pangasius exports have declined sharply. Currently, Vietnamese pangasius is exported to 149 countries around the world, including some countries that particularly favor pangasius a lot such as: China, USA, EU and ASEAN (*Detail at table 3 in annex)*

Figure 10: Current status of pangasius exports, 2015-2020 (Value: 1,000 USD)



Source: VASEP, 2020

1.3. RESEARCH OBJECTIVES AND SCOPE

The Mekong delta is a region with great advantages for aquaculture in Vietnam. However, current **aquaculture in the Mekong delta is still dominated by small-scale farmers, nearly 90% of shrimp farming area belongs to small households, and about 35% of pangasius farming area owning by small households**. Currently, small-scale aquaculture households in the Mekong delta are facing many problems and challenges such as: fragmented small-scale production; low productivity; low farming technologies; low quality of aquaculture products not meeting high-end markets requirements; poor accessing to quality production inputs such as seeds, feed, and biological products; lack of access to new technologies; lack of access to financial services; limited capacity in good aquaculture practices, climate change adaptation, disease prevention and mitigate environmental pollution. Additionally, small-scale aquaculture farmers have relatively low participation and representation in sustainable supply chains led large companies.

Vietnam is the largest seafood exporter to the Netherlands and has great potential to expand trade and cooperation when the EU-Vietnam Free Trade Agreement (EVFTA), which is ratified in 2020. However, the Vietnamese aquaculture in the Mekong delta is facing significant challenges related to sustainable development due to the risks of disease, climate changes, market challenges, and environmental pollution pressure. **The challenges faced by Mekong delta aquaculture industry can be solved partly through promoting Dutch cooperations in terms of technical expertise, investment, and market connections** between the Vietnamese shrimp industry and Dutch professional agencies and businesses. Dutch businesses in the field of aquaculture have been initially successful in Vietnam, such as: **De Heus and Nutreco** have invested in aquaculture feed production; **Skretting Vietnam** and Nutreco/SHV Holdings have a strong commitment to Vietnam's shrimp farming industry; **Fresh Studio** is investing in researching solutions to improve the quality of pangasius breeds in the Mekong delta, and **Rexil ASIA** supplies medicinal products and biological products to the industry, etc.

Challenges to the sustainable development of the Mekong delta aquaculture industry can be resolved through connecting public-private cooperation, technological development and adoptions, investment and trade promotion between in the Mekong delta aquaculture industry and the Netherlands. Therefore, the purpose of this study is to increase the understanding of the needs and challenges facing by small-scale aquaculture farms, shrimp and pangasius specifically. The study will explore factors influencing small-scale aquaculture farmers in their production and business decision-making. These insights facilitate the identification of suitable interventions and opportunities for technological innovation, investment, and business cooperation between the industry and the Netherlands to support sustainable small-scale aquaculture farmers in the Mekong delta.

1.3.1. Research Objectives

The project's goal is to ***gain a comprehensive understanding of the challenges faced by small-scale aquaculture farmers in the Mekong delta and to identify their specific needs for improving their production and business efficiency and sustainability***. The research results will facilitate the identification of potential opportunities to increase the participation of small-scale farmers in sustainable seafood production and supply chains in the Mekong delta, and international markets.

1.3.2. Research area and scope

Can Tho province: Can Tho city is located in the Hau riverbank with total area of 1,438.96 km2, accounting 3.49% of the whole area. The North of the province adjoins at An Giang province; the South adjoins to Hau Giang province; the West adjoins to Kien Giang province, the East adjoins to Dong Thap and Vinh Long province. **Can Tho city is located in central of the Mekong Delta**, in the trade axis of Long Xuyen quadrangle , Ca Mau peninsula, Dong Thap Muoi and Ho Chi Minh city. Over the years, aquaculture has been sustainably developed in Can Tho, a land of criss-crossing canals along the Hau River.

By the end of 2021, the area for pangasius farming was 621 hectares with an output of 175,456 tons. Average yield is 325 tons/ha. Of which, the total area of food-safe pangasius farming is 296 hectares, with VietGAP (282ha), BAP + ASC (14ha) and ASC (4ha) certifications. The total number of establishments granted pond identification codes in the province is 215, with an area of 445.2 hectares, representing 740 ponds, including 03 cooperatives (Thoi An, Thang Loi, Thot Not) with an area of 40 hectares. 08 enterprises (Bien Dong, Mien Nam, NTSF, Cat Tuong, Hai Sang, Co May, Caseamex and Quoc Tran) with an area of 49 hectares, 35 households affiliated with Sao Mai enterprise, Bien Dong... with an area of 95 hectares and 153 single households with an area of 265 hectares (accounting for 50%)

Vinh Long province: Locates in the centre of the Mekong Delta, southern Vietnam, Vinh Long province is lying between two major rivers namely Tien River and Hau River, 136km far from Ho Chi Minh City to the north, 33km from Can Tho city to the south, 43 km far from Tra Noc International Airport – Can Tho city. Its area of 1,520km2 is surrounded by Tien Giang province and Ben Tre province in the north and northeast, Dong Thap province in the northwest, Tra Vinh province in the southeast, Can Tho city, Hau Giang and Soc Trang provinces in the west.

Fishery is the second strong potential following the rice farming. Some main aquatic products namely catfish, red tilapia etc. According to the Department of Animal Husbandry, Veterinary and Fisheries (Department of Agriculture and Rural Development of Vinh Long province), **by the end of 2021, the area of intensive pangasius ponds in the province was over 434.62 hectares**. The whole province has 171/212 pangasius farming establishments, 41 establishments are suspending ponds and changing farming species. Among them, there are 18 companies and nearly 194 farming households. Output in 2021 will reach over 80,200 tons. The total number of facilities granted pond identification codes in the province is 181, with an area of 442.16 hectares, representing 685 ponds.

Decision No. 1633/QD-UBND approving the project "Supporting the construction of food-safe pangasius farming areas according to VietGAP advanced farming process for the period 2023 - 2025", under the Agricultural Extension Program with an area of 500 hectares.

Bac Lieu province: Bac Lieu is a coastal province located on the Ca Mau peninsula, with a total natural land area of about 246,872 hectares, with 56 km of coastline and 127,851 hectares of aquaculture land. Bac Lieu has diverse climate conditions, land, and water sources, and has great advantages in developing aquaculture and brackishwater shrimp farming. Bac Lieu has several sub-regions such as: shrimp farming area south of National Highway 1A raising intensive/semi-intensive; In the past two years, the super-intensive farming model has been developed, making Bac Lieu the shrimp "capital" of the country.

By 2023, Bac Lieu will have 157,000 ha of aquaculture, of which shrimp production areas account for 137,000 ha (*123,000 ha of Black tiger shrimp and 13,700 ha White-leg shrimp)*. **The province has 6,000 ha of super-intensive shrimp farms and 23,000 ha of intensive and semi-intensive farms**. Additionally, the province has nearly 40,000ha of shrimp-rice farming that produces high-quality shrimp and rice.

With a coastline of 56 kilometres, the province has brackish and freshwater areas suited for breeding aquatic species. By 2023, the province has 190 cooperatives in the agricultural sector (*of which 60 aquaculture cooperatives*) with a total charter capital of more than 143 billion VND and several members of 9.359 people. Aquaculture in Bac Lieu has a fast growth rate, according to statistics, in 2000 aquaculture production was only 22,366 tons, increased to 191,584 tons by 2015 with an increase of 8.6 times. However, there are still some shortcomings and limitations due to objective and subjective reasons such as: shrimp farming infrastructure do not meet the requirements of intensive shrimp farming; product safety and hygienic food products; production planning and planning management have not been seriously implemented; no close connection between planning raw material production areas and processing capacities.

Ca Mau province: Ca Mau is the only province in the country which has three sides bordering the sea with a total coastline of more than 250km, accounting for one third of the coastline of the whole Mekong Delta. Ca Mau has an interwoven system of canals, accounting for 4% of the natural area of the province. In addition, **Ca Mau is also the province with the largest area of mangrove forests in the country with nearly 72,887 hectares**, concentrated in Ngoc Hien, Nam Can, Dam Doi and Phu Tan districts. Therefore, Ca Mau has great potential to develop its fisheries and aquaculture industry.

The area of aquaculture in 2023 reached 300,000 ha, and shrimp farming alone reached 280,000 ha, with many types of farming such as intensive farming, super-intensive farming, cultivation, improved cultivation, shrimp-rice, shrimp-forest, shrimp farming in combination with other subjects such as crabs, scallops, etc.; mainly shrimp, prawns, and white shrimp. The province has formed two distinct shrimp farming areas: the North mainly specializes in shrimp-rice rotation model; The South mainly specializes in monoculture shrimp farming and polyculture shrimp-forest model. Although improved extensive shrimp farming model is still dominant; there was an initial conversion to the intensive/semi-intensive farming model with an average growth rate of 28.6%/year (from 3,511 hectares to 9,597 hectares). Currently, Ca Mau's ecological shrimp brand is very popular around the world. In the next two years, Ca Mau will recognize the entire shrimp farming area under the forest canopy as meeting ecological farming standards (21,784 hectares). This is important to promote Ca Mau shrimp brand in the world market, aiming to increase its added value and sustainable development.

1.4. RESEARCH METHODS

Detailed description about research method is shown at annexes.

PART 2. RESEARCH RESULTS

2.1. Aquaculture households' characteristics

Vietnam is the second largest shrimp producer in the world after China, contributing about 15% of global shrimp production value (VASEP, 2023). Vietnam's shrimp output reach 1 million tons, with an export value of 4.3 billion USD in 2022 (Directorate of Fisheries, 2023). The export value of farmed shrimp makes the largest contribution to Vietnam's seafood export value, accounting for about 50% of the country's seafood export turnover (Boston Consulting Group, 2019). Currently, **the total shrimp farming area reaches 747,000 hectares, of which the farming area for black tiger shrimp (Penaeus monodon) and White-legged shrimp (P. vannamei) are 610 thousand hectares and 117 thousand hectares**, respectively (Directorate of Fisheries, 2023). The shrimp farming industry creates jobs for about two million workers at about 220,000 shrimp farms concentrated mainly in the Mekong delta.

The area of pangasius farming in the Mekong delta is about 6,000 hectares, concentrated in the provinces of An Giang, Dong Thap, Ben Tre, Can Tho and some provinces with access to freshwater sources such as Soc Trang, Vinh Long, Long An, Tien Giang, Hau Giang. In provinces with large pangasius farming areas such as An Giang and Dong Thap, the number of small-scale pangasius farming households has decreased significantly, and the pangasius farming area is concentrated in large-scale farming households and companies. Currently, in Dong Thap, **96% of pangasius farming area are coded, and have been granted production identification** (ID) to pangasius farming businesses, cooperatives, and households. In particular, pangasius farming area codes have been granted to more than 1,600 hectares/1,770 pangasius farming ponds for 18 companies and 180 individual households. Dong Thap province has 378 pangasius farming facilities, including 78 farming facilities belonging to enterprises with more than 661 hectares, and 300 farming facilities belonging to individual households with nearly 967 hectares. In An Giang province, the province has a stable pangasius farming area of 1,500 - 1,600 hectares in Chau Phu, Chau Thanh, Cho Moi districts, and Long Xuyen city. An Giang has granted pangasius farming area codes for 90% of its pangasius farming area. Pangasius farming area in An Giang is concentrated mainly in large-scale farming areas such as Nguyen Van Nhan's household of 120 hectares, and farming areas of enterprises. Currently, in the Mekong delta, small-scale pangasius farming households only account for 20-30% of total pangasius farming area, concentrated in provinces such as Vinh Long, Can Tho, Tien Giang, and Hau Giang.

Thus, in the shrimp farming industry, due to the high number of small-scale shrimp farming facilities, and high risk level of shrimp farming, leading to the **majority of shrimp farming are small-scale households, with a shrimp farming area of less than 3 hectares/household, estimated to account for more than 85% of shrimp farming units**. Large-scale shrimp farming households and businesses/companies only account for less than 15% of shrimp farming units.

In the meantime, the trend of production concentration in pangasius farming is shifting faster than shrimp. Most households/units raising pangasius concentrate on a scale larger than 3 hectares/household. Pangasius farming has been affected less from environmental risk compared to shrimp. In addition, pangasius farm requires much larger investments. Therefore, pangasius farming tends to concentrate quicker to a larger production scale.

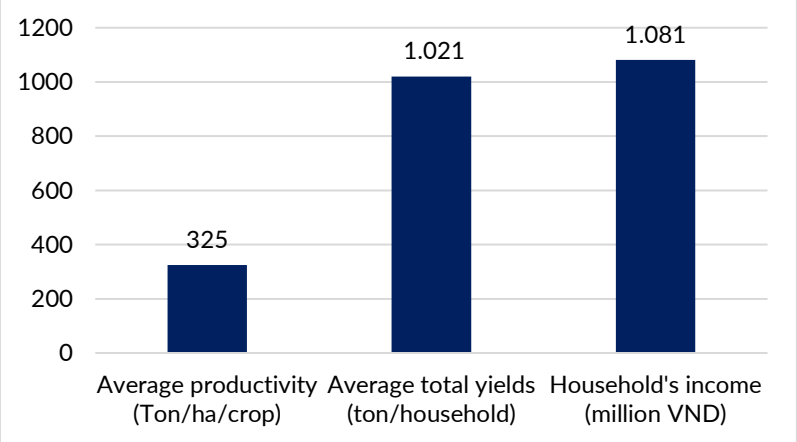
At present, **up to 70-80% of Pangasius farming units is on a large-scale, operated by well-off households and companies**. Only about 20% of pangasius farms are on small-scale operating by individual households, but most of them run a pangasius farming in association with and/or under a contract with a processing company.

From the results of our survey of 44 small-scale pangasius farming households in Can Tho and Vinh Long, and **103 shrimp farming households in Bac Lieu and Ca Mau** province, we found that households raising brackishwater shrimp and pangasius have some of the following characteristics *shows at table 5 in annex* .

The average size of a shrimp farming household is 4.5 people/household while that of a pangasius farming household is only 4.2 people/household. The overall household size is quite small, reflecting the current situation that labor supply in the Mekong delta is no longer as abundant as before. The **number of workers participating in aquaculture in households ranges from 1.7 people to 2.1 people for pangasius and shrimp respectively**. This data reflects the fact that shrimp farming requires more labor to prepare and clean ponds, to feed shrimp, to manage water quality, and harvest than compared to pangasius farming. Pangasius farming requires less labor to take care and to manage ponds compared to shrimp farming.

Furthermore, pangasius farming households are often located in freshwater areas, in the main region of the Mekong delta, with many alternative agricultural production activities such as growing rice, fruit, and small industrial and service labor. Shrimp farming households are often located in coastal areas, with fewer livelihood options because agriculture, industry and service activities are less developed.

Figure 11: Pangasius production of HH in 2022



Average income of a shrimp farming family in the survey sample is 195 million VND/year, which is about more than 16 million VND/month, and this source of income mainly comes from shrimp farming (83%); In which ecological shrimp farming households (improved extensive farming, shrimp-rice, shrimp-forest) have an income of only nearly 102 million VND/year; Semi-intensive shrimp farming households have an income two times higher than ecological shrimp farming households, 217 million VND/year; and intensive shrimp farming households have double income then the semi-intensive shrimp farming households, 452 million VND/year.

Despite higher income, **intensive and semi-intensive shrimp farming requires higher investment, has more risks in terms of diseases, farming techniques, and market risks than ecological shrimp farming**. But in recent years, due to the higher attraction of imports, the trend of people switching from ecological shrimp farming to semi-intensive and intensive shrimp farming has increased.

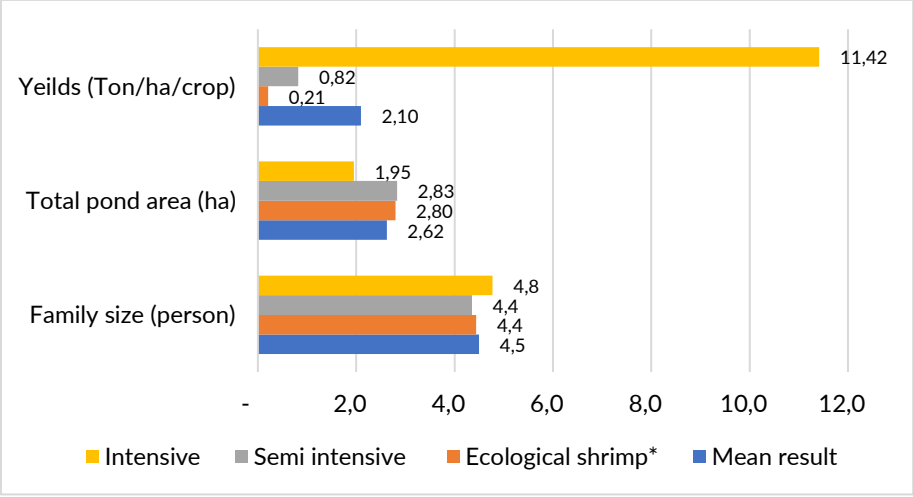
This trend is accompanied by an increase in environmental pollution, disease risk, and higher market risks for the shrimp farming industry. **To reduce disease risks in semi-intensive and intensive shrimp farming, farmers and businesses are now increasing the application of science, innovation in farming technology, environmental management, shrimp health management, managing water quality** to reduce disease outbreaks and farming shrimp in a closed model reduces impacts from the outside environment. Although there have been initial successes, this trend has a negative impact and causes environmental pollution outside the farming area, and increases risks for shrimp farming in the future; may lead to stopping shrimp farming in the future as has happened in some countries around the world.

Most aquaculture farmers produce shrimp and fish based on their experience and/or learning from each other's in the community, accounting for 60% of shrimp farmers, and 50% of pangasius farmers. The number of farmers who have been trained in a formal training program is only 40% in shrimp farms and 50% in pangasius farms. **Aquaculture farmers do not appreciate the effectiveness and usefulness of the formal aquaculture training programs they have accessed to**. Because aquaculture requires a lot of skills and knowledge, farmers who still participate in aquaculture often have intensive years of experience. Shrimp farmers have an average of 18 years of experience and pangasius farmers have an average of 16 years of experience.

A noteworthy point is that farmers participating in intensive farming are younger and have fewer years of experience than farmers engaged in semi-intensive farming and traditional ecological shrimp farming. This fact shows that the intensive shrimp farming model requires higher investment, more complicated farming techniques and technologies, therefore it is suitable for younger farmers, who are boldly switching to investing in intensive shrimp farming.

Majority of farming households in the survey sample are small and medium-sized households with the average water surface area of shrimp farming households of 2.62 hectares/household, of which ecological and semi-intensive shrimp farming has a surface area of 2.8-2.83 ha/household, which are larger than that of intensive shrimp farming model, 1.95 ha/household. Intensive shrimp farming models require more water treatment area, and smaller pond size, so on average each intensive shrimp farming farm has about 4.7 ponds while semi-intensive farming farms only have only 1.7 ponds/household and ecological shrimp households have 1.4 ponds/household.

Figure 12: Shrimp farmer household profile in 2022



Intensive shrimp farming models require water treatment areas, and smaller pond size.

Therefore, on average each intensive shrimp farm has about 4.7 ponds; while semi-intensive shrimp farms have only 1.7 ponds/farm, and ecological shrimp farms have 1.4 ponds/household. The average area of a shrimp pond in the intensive shrimp farms is about 2700m^2/pond; semi-intensive shrimp farm is about 1.3 hectares/pond; ecological shrimp is about 1.5 hectares/pond. **For pangasius, the average area of a farming pond is 6000 m^2/pond.**

On average, **shrimp farming households have a total output of 5.5 tons in 2022**; The lowest is ecological shrimp, only 0.58 tons, semi-intensive shrimp 2.32 tons; The highest is intensive shrimp, 22.26 tons. Thus, the **average annual productivity of surveyed households is 2.1 tons/ha** for shrimp farming in general; ecological shrimp is 210 kg/ha; semi-intensive shrimp is 0.82 tons/ha, intensive shrimp is 11.4 tons/ha, and pangasius is 325 tons/ha *(Details shows at table 6 in annex).*

The productivity of Vietnam's intensive pangasius and shrimp farming is quite high compared to the region and competitors. However, the model of intensive shrimp farming and pangasius farming in Vietnam require large investments, so production costs are high compared to its competitors. On the other hand, the productivity of ecological and semi-intensive shrimp farming in Vietnam is quite low compared to the region and competitors. This demonstrates a deterioration of the farming environment in Vietnam compared to other countries in the region and competitors. That is why Vietnam's farmed shrimp products are currently difficult to compete with other countries and competitors in both traditional ecological farming models and high-tech intensive farming models.

2.2. Technical specifications & production criteria

Shrimp farming season in the Mekong delta usually takes place from March to September, could be slightly vary (sooner or later) because of the favorable season, high and stable temperature, little rain, so water environment is quite stable for shrimp to grow. **From October to the beginning of following year, the temperature drops and often heavy rains, so the environment fluctuates strongly and the risk of disease is high**. Therefore, farmers limit stock shrimp farming during this period. **The shrimp farming period among surveyed households only lasts 6-7 months/year for intensive and semi-intensive shrimp, and 10 months/year for ecological shrimp**. In the intensive shrimp farming model, farmers use farming techniques to limit the impacts of environment and shortening the farming period to only about 120 days/crop, shorter than semi-intensive shrimp, 195 days/crop; and ecological shrimp 230 days/crop.

Figure 13: Aquaculture production criteria

Stocking density of ecological shrimp is only about 2-3 fingerling/m^2, households only stock seeds and do not supplement feed. In the ecological shrimp model, households' stock and catch large-sized shrimp and then add additional seeds into ponds. The main farming species is the black tiger shrimp. Because shrimp seeds are released into an almost natural environment with many natural enemies, the **survival density of the ecological shrimp model is very low, only about 15%.** If farmers stock larger sized shrimp, they will be able to improve the survival rate in the ecological shrimp model. The low survival rate is also a point where ecological shrimp farming models can be addressed to improve its farming processes to increase the survival rate, thereby improving the economic efficiency of the ecological shrimp model *(Details shows at table 7 in annex).*

Currently, **the intensive shrimp farming model applies farming techniques in 2-3 farming stages**. In phase 1, during the first 30 days, small shrimp breeds are raised in small ponds, with better control of environmental quality and feeding regime, thereby improving the survival rate of shrimp in the early stages. In the later stages, when the shrimp are larger, they are raised in large ponds with enough space for the shrimp to grow its biomass. The staged-based farming model significantly improves survival rate and farming productivity, up to 10 times higher than the 1-phase semi-intensive farming model.

The survival rate of pangasius farming is only about 52% in surveyed households, a large decrease compared to the survival rate of nearly 90% in previous years. There are many reasons why the survival rate in the pangasius farming model decreases: the quality of fingerlings decreases; farming environment is degraded due to reduced water quality; diseases are increasingly accumulating and arising. Therefore, farmers are increasingly stocking more densely to compensate for the high mortality rate. **The stocking density of pangasius ponds is about 60 fish/m^2**, so 1 hectare stocked about 600,000 fingerlings/ha, the average price of pangasius fingerlings is 1,000 VND/fish, so the seed cost is 600 million VND/ha; **With a survival rate of 50%, the number of pangasius seed that die and is lost is 300 million VND/ha.** An average pangasius farming household has 3 hectares of pond, so the value of fish seeds lost due to fish death is about 900 million VND/household, which is a huge amount of money. Calculated on the total pangasius farming industry, **with 6,000 hectares of pangasius ponds, the total loss due to poor seedling quality is 5,400,000 million VND/year, equivalent to 220 million USD/year**. If you add in shipping costs, lost feed and operating costs when raising these dead pangasius fingerlings, the loss to the pangasius industry is huge.

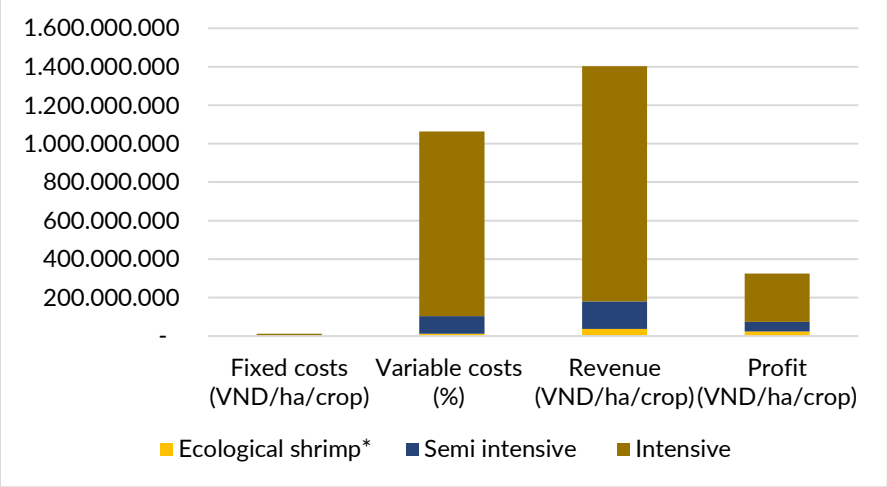
Therefore, improving the quality of pangasius breeds, and finding suitable technical measures, and technologies to improve the survival rate in commercial pangasius farming is an opportunity to bring great benefits to the pangasius industry.

Feed conversion ratio (FCR) is relatively high of 1.49 for shrimp and 1,7 for pangasius. FCR at intensive shrimp farms is 1.48 is equal or a bit less than that at semi-intensive shrimp farms, 1,51. This fact reveals that in the intensive shrimp farming model, farmers employ better water management techniques to keep water environment better for shrimp so it can improve the FCR. FCR at shrimp farming in Vietnam are higher than that in other countries, showing that environmental quality for shrimp farms is better than in other countries. **The FCR of pangasius is at 1,7**, was high in increased compared to that of previous years, showing that **seedling and feed quality were getting worse over the years.**

2.3. Aquaculture farm economic analysis

The investment scale of aquaculture models is highly varying. Investment costs can be divided into two types: **fixed costs and variable costs**. Fixed costs relate to the costs of acquiring land and water surface for aquaculture; households can reclaim, buy, or rent land. **Most shrimp farming households have their shrimp pond area acquired from previous land reclamation**, so this cost is almost non-existent. For pangasius farming households, most households also have pond areas due to previous land allocation, only a few households have to buy land, so on average out of more than 40 pangasius households surveyed, the cost farming land rental fee is 90 million/household for pangasius farms.

Figure 14: Investment cost of 1 shrimp HH in 2022

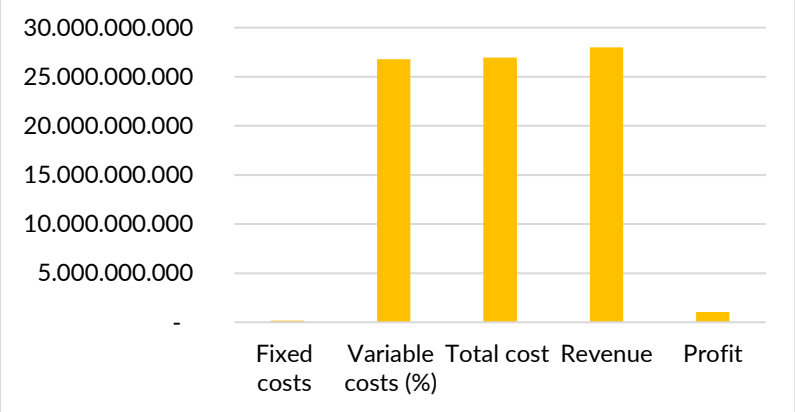


Once they have land, farming households must invest in digging ponds, building banks, building water supply and drainage sewers, investing in machineries such as pumps, generators, fan and aeration systems, and construction of temporary housing and storages. These fixed costs are depreciated, with the pond and factory being depreciated over 10 years, machinery being depreciated over 5 years, and fan, aeration, and feeding systems being depreciated over 3 years. Figure 14 above shows that the **intensive shrimp farming model requires greater initial investment costs than the semi-intensive and ecological shrimp farming models.** With the ecological shrimp farming model, the initial fixed costs are mainly pond consolidation, water supply and drainage; With the intensive shrimp farming model, farming households must invest in additional pumps and fan systems; As for the intensive shrimp farming model, farming households will have to invest in additional machinery such as generators, aerators, auxiliary buildings and warehouses.

This is because the intensive shrimp farming model requires more careful care and attention. Farmers must be present regularly and monitor growth and pond environment more closely. Therefore, the intensive shrimp farming model needs a house for farmers to take care of and monitor the shrimp, as well as a warehouse to store food and machinery. **With the intensive shrimp farming model, the ponds usually have a small area, an average of about 3,000 m^2/pond**, and households will build many ponds for continuous stocking and overlapping farming seasons. Therefore, the cost of pond excavation in the intensive shrimp farming model is much greater than the other two shrimp farming models.

For Pangasius farming households, the initial fixed cost of digging a pond is quite large because Pangasius farming ponds usually have to be solid and sturdy. Currently, pangasius ponds are about 5-7 meters deep. The embankment is solid and has a solid water supply and drainage system. Pangasius farming households must also invest in supply and drainage canal systems and high-capacity pump systems because ensuring enough water for pangasius ponds is very important. Therefore, to invest in pangasius farming, the initial pond investment cost is large, and **pangasius ponds can hardly be converted to other types of production and farming if pangasius farming is ineffective**. Therefore, deciding to invest in pangasius farming is an important and difficult decision for people to make. It requires people to have large capital and perseverance, so the investment in new fishponds does not fluctuate much *(Details shows at table 8 in annex).*

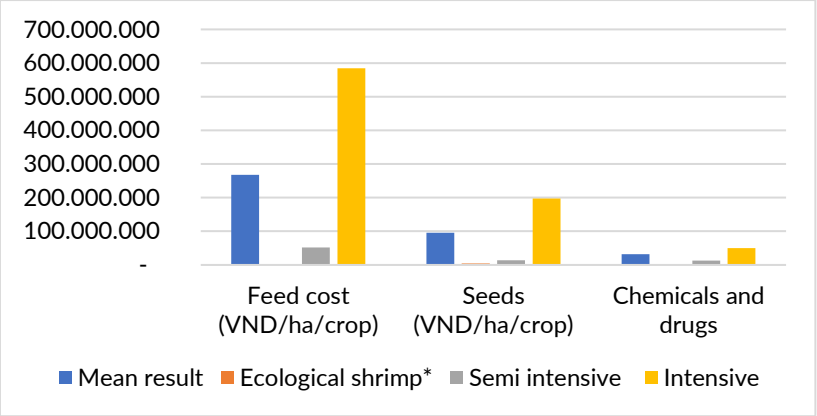
Figure 15: Investment of 1 pangasius farming HH (3.14ha) in 2022



Variable costs in aquaculture models are feed costs, seed costs, medicine and chemical costs, fuel costs, annual pond dredging and renovation costs, and labor costs, and other annual variable costs. In shrimp farming models, **the average feed cost accounts for 57% of the total cost, of which the intensive farming model has the highest feed cost at 60%; Semi-intensive farming model accounts for 56%, while in the ecological shrimp model there is no feed cost**. Seed costs account for 20.5% of the total cost of shrimp farming. Thus, **feed and seed combined account for 78% of the total cost of shrimp farming.** Therefore, ensuring good quality and suitable prices of feed and seedling are two very important factors that determine the profitability of shrimp farming households.

Drug and chemicals are the third most important factor in the production cost structure, accounting for 6.8% of total shrimp farming costs. Drug and chemicals help stabilize the farming environment, increase shrimp health and play an important role in the success of shrimp farming. Currently, there are hundreds of companies providing thousands of drug and chemical products to shrimp farmers. Therefore, ensuring access to quality drugs and chemicals at reasonable prices is a very important factor for farmers. Fuel costs (electricity, gasoline) account for about 5.5% of the total cost of shrimp farming.

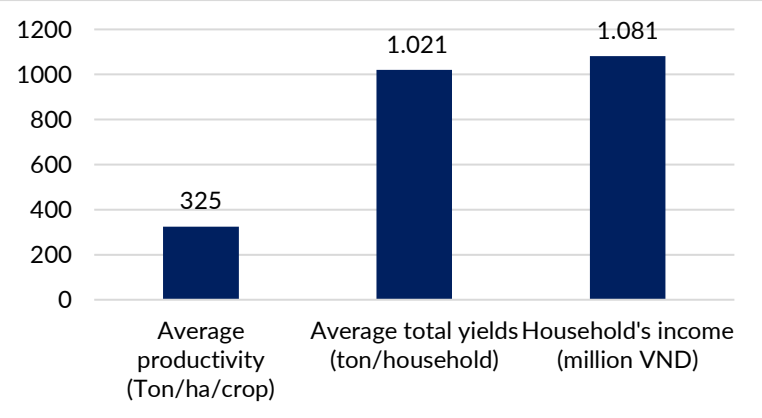
Figure 16: Status of shrimp HH access to input in 2022



Ensuring a stable source of electricity and fuel determines the success or failure of the farming household, especially with the intensive shrimp farming model, where fans and aeration cannot be stopped, and automatic pond sludge pumps, and monitoring of environmental and health indicators are continuously needed for farmed shrimp. **Fuel costs in the ecological shrimp model are lower than the semi-intensive model and lower than the intensive model**. Therefore, only farming areas with good electrical/energy infrastructure can develop intensive shrimp farming. Currently, **a model of solar power combined with intensive shrimp farming is being tested and developed, showing the potential to bring benefits to farming households**. In addition, farming households also have to pay the cost of dredging sludge and improving ponds, accounting for an average of 4% of shrimp farming households, in which this cost is high for intensive farming models because sludge removal is difficult. performed continuously and automatically using a suction pump; The cost of dredging sludge and improving ponds is greater in semi-intensive farming and ecological shrimp models because pond sludge accumulates until the end of the season or the whole year before being dredged. **The cost of hired labor accounts for a small percentage, about 3%; Interest expenses account for about 2%.**

For pangasius farming households, the cost structure is like that of shrimp farming households. **Feed costs account for 84% of total farming costs, breeding costs account for about 7.5%, drug and chemical costs account for 3%, loan interest costs account for 2%, labour costs account for 1%, fuel costs are about 1%, while other costs such as transportation**, and pond renovation account for less than 1% each. For pangasius farming households, if they can improve seed quality and increase the survival rate of the fish, costs will be reduced quite a lot, estimated at 4-10% of total costs. **Feed quality and price of pangasius feed are also key factors affecting the costs and profits of pangasius farming households**. Currently, most of the ingredients for pangasius feed are imported, and prices have increased due to fluctuations in the world markets, causing the selling price of pangasius feed to continuously increase. Furthermore, the current manufacturers and suppliers of pangasius feed are concentrated in a few large enterprises, so there may be some market powers and their ability to impose higher selling prices to cause the price of pangasius feed to increase. Pangasius feed quality is also an issue that needs improvement; Currently, farmers do not have assurance from competent independent professional agencies or associations about the quality of pangasius feed. There is a phenomenon of poor-quality raw materials and indigestible protein ingredients being mixed into fish feed, causing farmers to suffer losses during the farming process. Therefore, proactively **using domestic ingredients to replace imported feed ingredients and good control of feed quality, ensuring healthy competition in the pangasius** feed distribution system are important steps to improve the economic efficiency of pangasius farmers in the Mekong delta.

Figure 17: Pangasius production of HH in 2022



The average profit in 2022 of a fish farming household in the survey sample is 1,042 million VND/household, while an intensive shrimp farming household is 490 million VND/household, a semi-intensive shrimp farming household is 140 million VND/household, and ecological shrimp farming households is 69 million VND/household.

However, a pangasius farming household needs a huge amount of investment capital, an average of 26.96 billion/year, and the **profitability rate is only 4%/10 months or about 5%/year**; This rate is only equivalent to the savings deposit interest rate. This shows that pangasius farming households do not have much ability to make high profits; When there are price and market risk fluctuations, pangasius farming households will not have the savings to withstand and will have to quit farming business and their pangasius farms maybe acquired by pangasius farming companies. This is a popular trend in the pangasius farming industry in the Mekong delta.

For intensive shrimp farming model, investment capital for production needs about 1.9 billion VND/year; This is quite a large capital for an average farm household. Therefore, only economically strong households can participate in the intensive shrimp farming model. The intensive shrimp farming model gives a profit rate of 26%/6 months, equivalent to 52%/year, which is a very large profitability rate. Therefore, although shrimp farming business has high disease risks, many households still participate because its profitability is so high.

For the semi-intensive shrimp farming model, the average investment of a farming household is 270 million VND per year, not too large and suitable for many farming households in the Mekong delta; The semi-intensive model gives a profit rate of 52%/7 months, or 90%/year. **The ecological shrimp farming model requires low investment capital, an average of 35 million VND/household; and give a very high profitability rate of 197%/10 months, or 236%/year** *(Details shows at table 9 in annex).*

2.4. Access to aquaculture inputs

2.4.1. Access to aquaculture seed

Hundred percent of shrimp farming households buy seeds from agents and seed suppliers in the region. Shrimp farming households mainly buy seedling from two large enterprises, Viet-Uc and CP, accounting for about 60%; the remaining households buy seed from other small businesses and seed supplying agents from the Central region, such as Ninh Thuan and Binh Thuan provinces. According to the Directorate of Fisheries, **in 2022, Vietnam produce 150 billion shrimp seeds, including 110 billion white-legged shrimp (TCT) and 40 billion black tiger shrimp seeds**.

According to the Department of Fisheries, by 2023, the Mekong delta have 1,236 brackishwater shrimp seed production facilities, of which 728 establishments are qualified to produce; and 893 brackishwater shrimp breeding facilities, of which 558 are qualified for production.

Table 01: Access to aquaculture seeding (%)

Criteria	Shrimp (Average)	Ecological shrimp	Semi Intensive Shrimp	Intensive Shrimp	Pangasius
Source of seeds					
- Natural seed (%)	0	0	0	0	0
- Artificial seed (%)	0	0	0	0	0
- Buying seed (%)	100	100	100	100	100
Origin of seeds & quarantine					
- Quarantined seed (%)	100	100	100	100	0
- Non quarantined seed (%)	0	0	0	0	100
Method of payment					
- Prompt payment (%)	100	100	100	100	100
- Payment in part (%)	0	0	0	0	0
- Deferred payment (%)	0	0	0	0	0

Survey results show that farming households use shrimp seeds purchased from hatchery production facilities. No household uses self-propagated seeds or produces seedling themselves. Buying seeds is relatively easy and convenient. However, aquaculture farming households must pay cash immediately when purchasing shrimp and pangasius fingerlings, and cannot buy on credit. According to survey results, **100% of shrimp farming households said they buy shrimp seeds with seed quality certification**. However, most farming households are not confident about the quality of shrimp seeds. Currently, there is no reliable intermediary providing reliable seed quality assessment services for farmers.

Hundred percent of pangasius farming households buy pangasius fingerling from local seed producers and fingerling supply businesses in the region. Pangasius farms reported that the pangasius fingerling they bought did not have seed quality certification. Pangasius farmers have to pay for pangasius fingerling immediately upon purchase. Pangasius fingerling quality is shown the problem of seed degeneration, decreased fish growing rate, and increased mortality and deformity rates over time. Currently, t**here are no regulations and quality quarantine services for pangasius fingerlings in localities**. There is no seed quality control process at farming households. Therefore, pangasius fingerling production units use a lot of antibiotics. **There is a need for high-tech pangasius seed productions in the Mekong Delta.** Currently, in 2023, the Mekong delta has **2,820 pangasius seed production facilities, of which only 116 facilities** have been inspected to meet production conditions. Pangasius fry is produced by farmers in Hong Ngu district, Dong Thap. In Dong Thap, there are currently about 75-80 private establishments producing fry, and about **1,000 facilities nursing pangasius from fry to fingerlings, about 3-5 cm in size/seed**. In addition to Dong Thap, pangasius fry and fingerling are also produced in An Giang, Long An, Vinh Long, and Can Tho. The total output of pangasius fry and fingerling in the **Mekong delta is estimated to be 30-40 billion fry and 3-4 billion fingerlings.**

Currently, some businesses have invested in pangasius seed production, such as **Vinh Hoan Company and Nam Viet Company,** to mainly serve the company's internal seed demand.

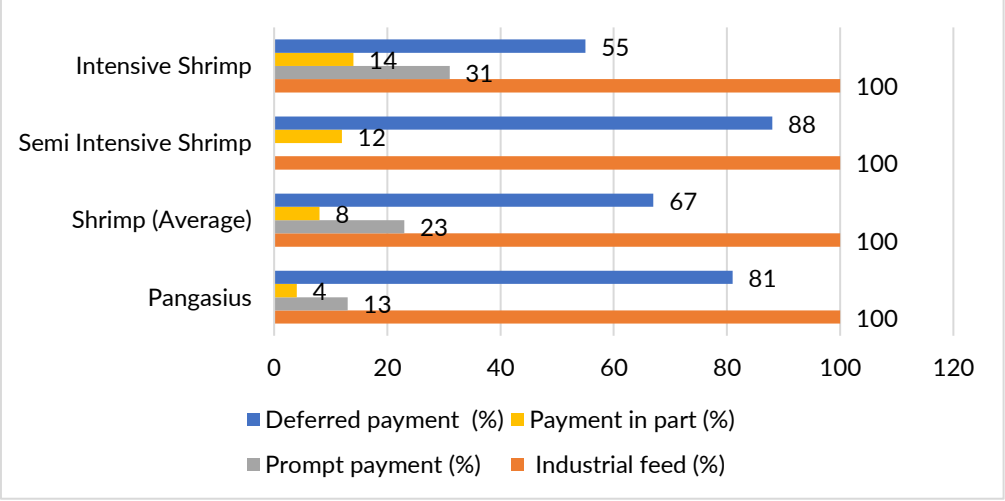
Some companies are conducting research on pangasius fingerling production to supply to the market such as **Viet-Uc, CP, Fresh Studio.**

However, it has been only under in testing and not yet been commercially produced. The enterprise has a project to renovate and improve the quality of pangasius breeds and apply disease vaccination. However, currently there are no standards or quality accreditation agencies. **Pangasius fingerling transported locally have not been quarantined**. Therefore, it is necessary to build a good quality control system for pangasius fingerlings.

2.4.2. Access to aquaculture feed

A hundred percent of surveyed households, intensive and semi-intensive shrimp farming households, are currently using industrial feed purchased from local feed agents. Ecological shrimp farmers do not use industrial feed. **The average feed conversion ratio FCR in shrimp farming households is 1.49. There is not much difference between semi-intensive and intensive farming**. Nearly 68% of households buy food for farmers in the form of deferred payment or credit from feed agents; and will pay for feed after shrimp harvest. The proportion of semi-intensive farming households buying on deferred payment is quite large, 88%; Meanwhile, intensive shrimp farming households are 55%. This shows that intensive shrimp farming households have better capital capacity than semi-intensive shrimp farming households. Shrimp farming households that buy feed on credit from the local farmers have to pay 15-20% higher feed prices for shrimp feed. **Pangasius farming households mostly buy food on credit from feed agents, with the purchase price being 30-40% higher than the purchase price on immediate payment.** Farmers pay feed agents when harvesting fish after 10 months of farming *(Detail shows at table 11 in annex).*

Figure 18: Access to aquaculture feed



Shrimp and pangasius farmers buy feed from local aquaculture feed dealers/agencies. The main shrimp feed production and supply companies in the Mekong delta are **Charoen Pokphand Group (CP), Grobest Holdings Limited, GrowMax group, Long Thang, Thang Long, Tong Wei, Skretting, UP, etc. About 85% of feed supply companies are FDI companies.** Shrimp feed prices have increased by about 20-30% since the end of 2022. Feed companies give discounts to food agents of about 30-35% depending on the company. Level I agents can transfer that discount to Level II agents up to 20%. Feed agents have local monopolies and can push up feed prices. In addition, feed agents have better access to bank capital than farmers, so they have better capital and can let aquaculture farmers buy feed on credit at much higher interest rates than bank interest rates.

For feed companies, each company has about 30 - 40 technical staff who often visit farmers' ponds and provide technical advice to farmers.

Besides, the company also has a Lab to test farmers for free fish and shrimp diseases. Previously, Pangasius feed dealers were small-scale and served a specific farming area. Currently, the scale of pangasius feed agents has increased greatly, and small agents are disappearing. A level I pangasius feed dealer supplies feed to a larger pangasius farming area; and the output of one agent can be up to 50,000 tons/year, equivalent to a revenue of about 40-50 million USD/year.

For households raising pangasius, **100% of fish farming households use industrial feed. Large pangasius feed production enterprises such as De Hues, Co May, Viet Thang, Proconco**. Feed ingredients are mainly imported (70%). About 85% of food supply companies are FDI companies. In the period 2015-2016, when the pangasius industry developed strongly, many pangasius feed factories were established, up to about 65 pangasius feed factories in the Mekong delta; **about 25 factories in Dong Thap, about 30 factories in Can Tho**, and the rest are in An Giang and Long An. Currently, due to the difficult market situation of pangasius consumption, the number of small-scale farming households has decreased, so the number of small pangasius feed factories has also decreased sharply. **Therefore, in 2023, the number of pangasius feed factories in the Mekong delta is about 40% compared to the peak period, equivalent to 30 pangasius feed factories**. Previously, pangasius factories were mostly domestic feed factories. But the current trend is that large FDI enterprises and foreign-funded funds now dominate the pangasius feed production industry, such as **Charoen Pokphand Group (CP), Cargill, De Heus, Proconco, Viet Thang, Co May, Vinh Hoan, Sao Mai**. Raw materials for producing pangasius feed are mainly from soybean residue, fishmeal, and additives, which are imported ingredients and account for a large proportion of fish feed ingredients. Rice bran, tapioca starch, and minerals are domestic ingredients that account for less than 20% of pangasius food ingredients. **Therefore, the price of pangasius feed is greatly affected by the price of feed ingredients on international markets**. The price of pangasius feed has increased continuously in recent times, due to the influence of the increasing trend of imported international feed raw material prices, increased international transportation and logistics costs, capital costs (interest productivity) increased. Therefore, small-scale pangasius farmers are passive about feed prices and cannot decide on the purchase price of pangasius feed. **Small-scale pangasius farmers are suffering heavy losses in the 2023 farming period.**

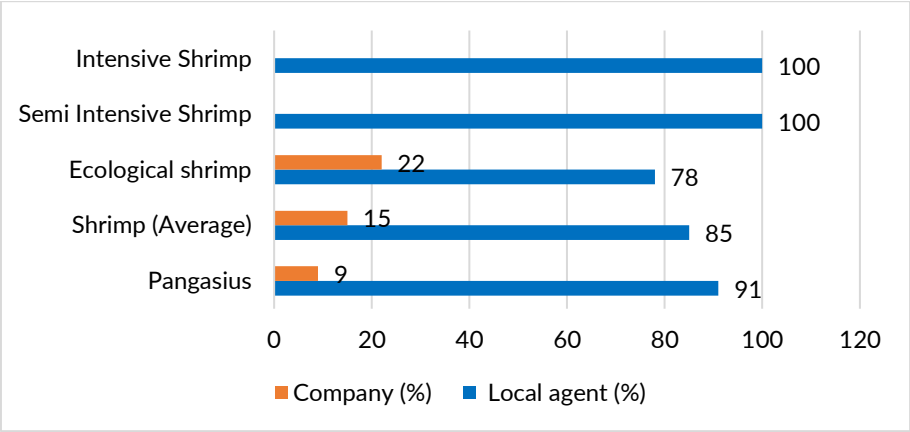
Aquaculture feed quality is also a problem that small-scale farmers are facing, because they lack information and measures to verify feed quality, especially for pangasius farmers. Currently, the feed conversion ratio in pangasius farming tends to increase to 1.7-1.8 compared to 1.2-1.4 in the past. Poor feed quality is also a factor affecting the FCR. Currently, in pangasius feed ingredients, there is a proportion of indigestible protein from palm oil, palm residue, and cotton residue. Therefore, authorities need to check and verify the quality of pangasius feed to help farmers. In addition, the pangasius industry needs to have research programs to improve feed formulas for pangasius, find alternative solutions and use domestic feed ingredients to reduce external dependency.

2.4.3. Access to drug and chemicals

Drug and chemicals play an important role in shrimp and pangasius farming. Survey results showed that **85-90% of farmers interviewed said they bought drugs and chemicals from local agents**, and a few bought directly from companies. Farmers who buy drugs and chemicals can pay immediately or defer payment after harvesting the product. 53% of farming households buy drugs and chemicals on deferred payment from local agents.

Thus, it can be seen as farmers are lacking working capital, so they still popularly buy materials on credit and pay a much higher interest rate than banks *(Details shows at table 12 in annex) .*

Figure 19: Access to drug and chemicals (%)



Drug and chemicals used in shrimp and fish farming can be divided into 3 groups: 1) Drug and chemicals to disinfect and improve the pond environment: currently there are about 17 types of chemicals belonging to the group of disinfectants and improving the environment of pangasius ponds. Example: lime, chlorine, potassium permanganate, etc. **For shrimp farming, there are 5 types of chemicals that farmers often use to improve the shrimp pond environment: chlorine, potassium permanganate, PAC, lime and EDTA**. Among them, chlorine, potassium permanganate, and PAC are the most popular. **Most shrimp farming households use probiotics, commonly used microorganisms include Bacillus subtilis, B. licheniformis, B. megaterium; 2) Drug and nutritional supplements, functional foods: currently there are about 18 different types such as vitamin C, Vitamin B12, Pro-enzyme, minerals, etc.; 3) Drug to prevent and treat diseases: for pangasius there are 19 products containing antibiotics such as: Ampicillin, Tetracycline, etc**.

Farmers have difficulties choosing appropriate drugs and chemicals to improve farming efficiency. The quality and origin of drug and chemicals for shrimp and pangasius farming are also very complex and unclear. Most people, 50-60%, use drug and chemicals empirically. People tend to abuse drug and chemicals in pangasius farming. Drug and chemical suppliers have not done a good job in providing and consulting information on drug and chemical quality and standards to farmers. Therefore, people choose to use drug and chemicals based mainly on experience and recommendations from agents and companies. Currently, there are so many businesses involved in producing, packaging, and trading in drug and chemicals for shrimp and pangasius farming; **The number can range from 500 to 1,000 companies**. Large enterprises participating in providing drugs and chemicals for shrimp farming include Elanco, INVE, Vinh Thinh, Thai Nam Viet, Tan Sao A, Tan Quang Minh, Golden Shrimp Biology, My Binh, Au My, Tan Hiep Phat, VEMEDIM, CP, etc. Large enterprises providing drug and chemicals in the Pangasius industry include: Vemedim, Bayer (currently Elanco), Minh Tan, BiOwish, UV, Southern Chemicals, PHARMAQ, VIBO, Vinh Thinh, etc.

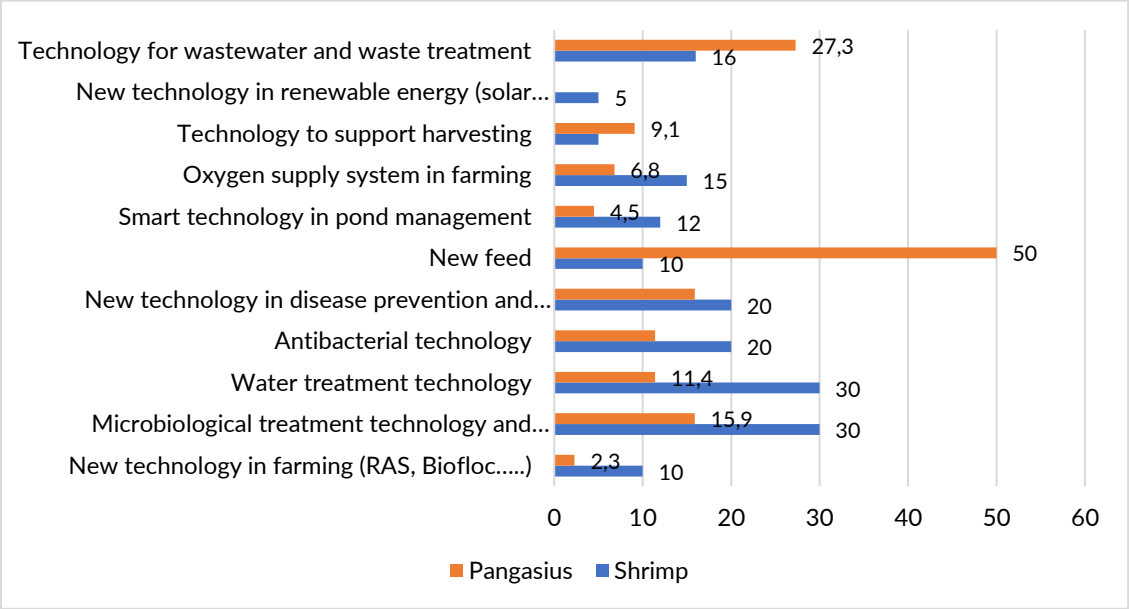
2.5. Access to new technologies

In the aquaculture industry in general and the shrimp and pangasius farming industry in particular, technology plays an important role and is changing quickly to adapt to new environmental challenges, climate change, and to improve efficiency.

For shrimp farming households, super-intensive shrimp farming model apply many new technologies, followed by intensive shrimp farming model, and pangasius farming households. Ecological shrimp farming households do not have much demand to apply new technologies. Intensive and semi-intensive shrimp farming households need to apply water treatment technology (30%), biological products to improve shrimp health (30%), sterilization technology (20%), and antibacterial technology (20%).

Disease prevention and treatment technology (20%), gas and oxygen supplementation technology (15%), smart pond management technology (12%), food technology (10%), closed farming technology (10%), and other technologies such as waste management, sludge settlement, feeding technology, harvesting technology.

Figure 20: Access to new technology (%)



Technology in the pangasius farming industry is less diverse and innovative than that in shrimp farming. Among them, technologies related to new feeds account for the majority (50%), wastewater sludge management technology (27%), followed by disease prevention and treatment technology (16%), and biological products to improve the environment. farming environment and fish health (16%), disinfection technology (11%), and water treatment technology (11%) *(Details shows at table 13 in annex) .*

Farming households access new technology through direct introduction by sales staff from companies. In addition, many farming households access new technology through demonstration models and seminars conducted by local agricultural extension and fisheries departments. Thus, farming households access through two main sources: public organizations: the fisheries department, agricultural extension centers (10-20%); and private enterprises, about 5%. However, for pangasius farming households, new feed technology is mainly provided by companies (43% of pangasius farming households). **Survey results show that the majority of farming households access new technology through informal channels from other farmers**; official channels from schools, research institutes, cooperative alliances, and NGOs play a very limited role *(Details show at table 14 in annex).*

Currently in the Mekong delta, there are many companies providing farming technology solutions such as: pond water treatment, aeration and oxygen generation, sludge dredging, sludge suction, feeding machines, shrimp counters, measuring and monitoring technology. Monitoring environmental indicators, testing for pathogens, etc. Technologies in the shrimp farming industry have had many innovations in recent years, and the industry is highly innovative and competitive. Applying technology towards mechanization and automation to reduce labour in shrimp and pangasius farming is a direction that needs to be promoted.

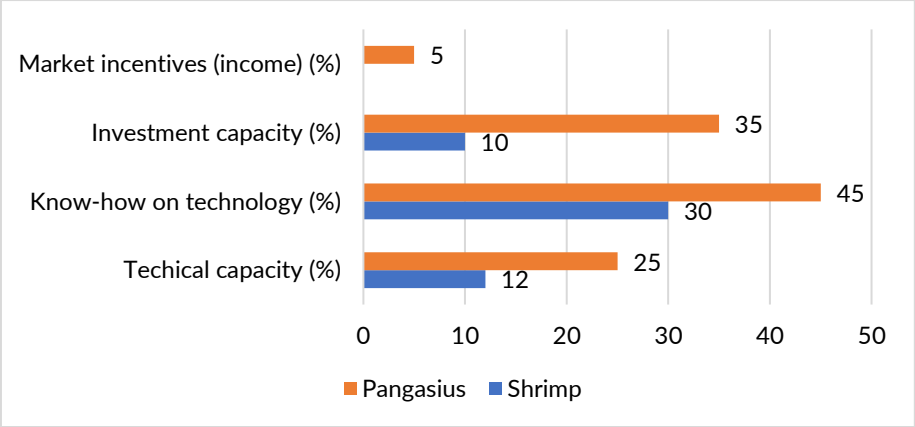
Applying IoT technology to monitor the environment, monitor the growth of shrimp and fish, monitor, and manage the health of shrimp and fish based on the flexibility and distribution of the population, measure the size and growth rate of fish. Shrimp and fish are also a direction for technological development.

Some large aquaculture enterprises also invest in developing new aquaculture technologies. Vinh Hoan Company is a leading enterprise testing new farming technologies, such as the pangasius farming model with limited water changes, using beneficial microorganisms, controlling harmful microorganisms, and limiting the use of antibiotics, and vaccinate fingerlings. Nam-Viet Company has built a modern farming area with nano-aeration technology and baking catalyst to treat water in ponds, no need to discharge pond water into the environment, no need to dredge pond bottom mud by hand-mechanical methods; towards high-tech closed double circulation farming, and fish excrement is recovered to make ecological fertilizer.

The water surface of the pond is used to place solar panels to supply the farming area. Processing by-products are utilized to make high-quality, high-value products. Signify company research and tests lighting technology, simulating the living rays of the sun, and finding suitable lighting modes that are beneficial for shrimp development, inhibit the growth of toxic algae, disinfect to create the best farming environment for farmed aquatic products. In addition, Signify also tests lighting modes in combination with feeding formulas to find the most suitable and effective farming solution. In addition, GIS technology to locate and identify pond codes, identify, and locate farming areas, and trace origins is a potential technology area that is being developed. Improving fish transportation technology and more effective input and output logistics for pangasius is an area that needs investment in research and development. Solar power, energy saving, and water saving technologies in farming and processing are also solutions that need to be developed for the pangasius industry.

However, small-scale farming households currently do not see many benefits from applying new technologies. This is reflected in the proportion of investment in fixed costs, including investment in technology, which only accounts for a very small proportion of the total production costs of shrimp farming households and pangasius farms. **The application of technology requires certain conditions such as knowledge and technology as well as investment capacity**. To promote technology companies to have better access to farming households, local governments need to have policies to invest in technology research and development, support testing of new technology and support the replication of new technology *(Details shows at table 15 in annex).*

Figure 21: Determinant of technology adoption (%)



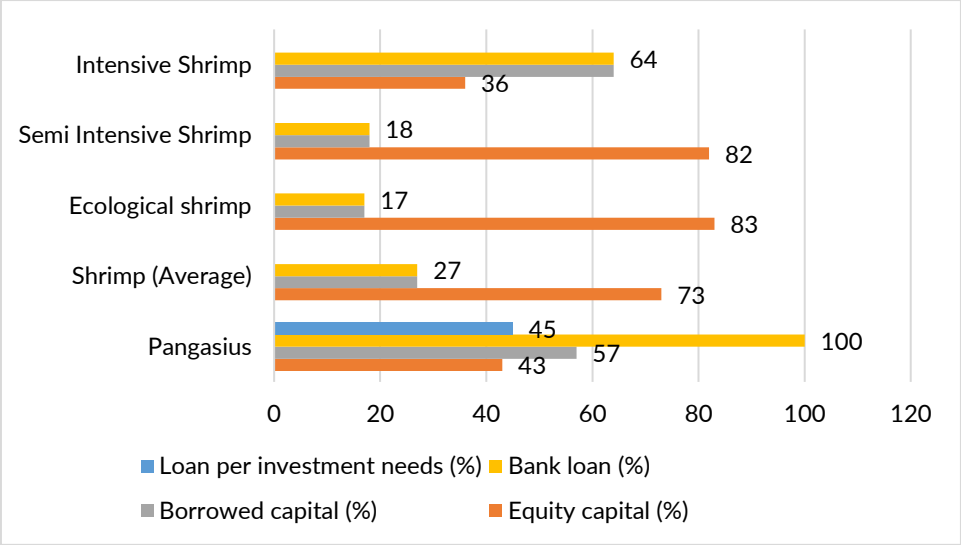
For small-scale farming households, the main motivations for farmers to apply technology in shrimp and pangasius farming are (i) Know-how on technology level of 30% for shrimp farming households and 45% for fish farming households investigate; (ii) Investment capacity, 10% for shrimp farming households and 35% for pangasius farming households; and (iii) Technical capacity, 25% for pangasius farming households and 12% for shrimp farming households. Thus, **understanding of technology and financial capacity to invest in technology are two key factors in farmers applying technology**. Therefore, local governments and public organizations need to promote support and investment to help improve farmers' understanding of technology; and build appropriate financial mechanisms, support funds and technology investment mechanisms to promote people to apply technology in aquaculture.

2.6. Demand and access to capital

According to survey results, the average investment cost of farming households on an area of 1 hectare of shrimp farming is 359 million VND/crop. The average shrimp farming area of a household in the survey sample is 2.62 hectares; Therefore, the average household's investment capital need for shrimp farming is 470 million VND/crop. The main investment cost structure includes: variable costs accounting for 99% of total investment costs, including main costs such as feed (57%), seeds (20%), medicine and chemicals (7%), electricity (5%), sludge removal (4%), labor (3%) and bank interest (2%). For pangasius farming households, the capital needed to invest in production is huge. On average, pangasius farming households need to invest 8.49 billion VND/ha/crop. The structure of investment costs of surveyed pangasius farming households is mainly: feed (84%), seeds (8%), medicine and chemicals (3%), and (iv) interest payments on bank loans about 2% *(Details shows at table 16 in annex).*

Investment capital for production of shrimp and pangasius farming households in the survey sample comes from 02 sources (i) households' own capital, accounting for 43%; (ii) bank loans, accounting for 57%. Current bank loans only meet 45% of the investment needs of farming households in the survey sample. In addition, farming households also take advantage of geographical sources of capital to provide feed, seeds, and drugs and chemicals through purchasing inputs and paying at the end of the season after harvesting shrimp and fish.

Figure 22: Demand and access to workinig capital (%)

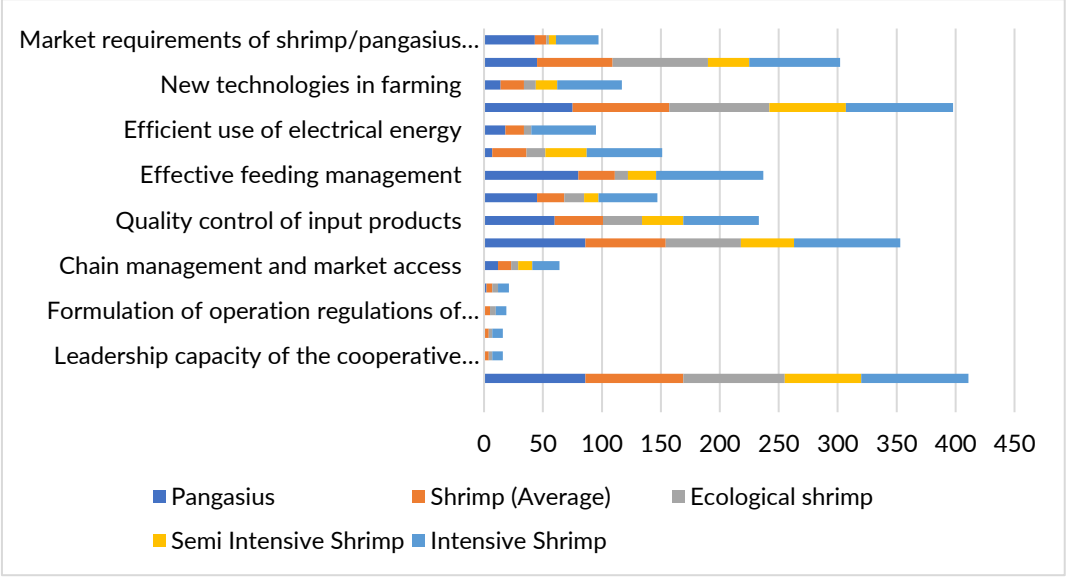


The method of buying and deferred payment commonly applied, 82% of pangasius farming households used deferred payment; 68% of shrimp farming households uses deferred payment for feed. Intensive shrimp farming households have a large investment level, so the bank loan rate is high (64%). Current bank loans only meet 40% of the investment needs of households, especially for intensive farming households. The banks that provide credit mainly to farmers are state-owned banks including Agribank and ViettinBank. The average loan term is about 10 months/year with an interest rate of about 7.5%/10 months, equivalent to an interest rate of 10%/year. The majority of shrimp farming households borrow using to land red-book as a collateral to borrow capital from state banks, so the interest rates are low compared to households borrowing for pangasius farming. Households borrowed to raise pangasius, had a large capital need, and they had to borrow according to their business plan, mortgaging their land use right licence.

2.7. Demand for technical training and information

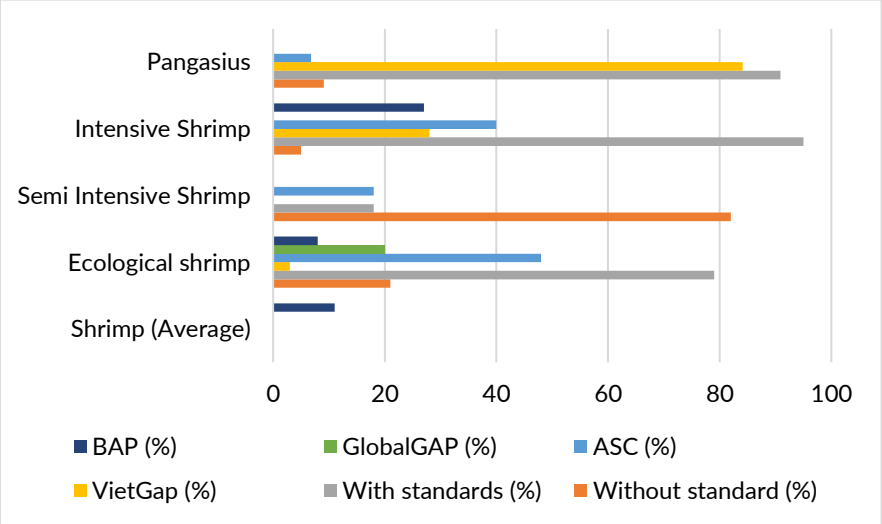
Shrimp and pangasius farming households in the survey sample in the Mekong delta have had access to many training courses, and sustainable production through annual training programs and conferences. Technical seminars organized by the Agricultural Extension Centre and Fisheries Sub-department in localities. Survey results showed that 83% of shrimp farming households interviewed said they had participated in at least one training course on shrimp farming techniques. Among them, intensive farming households have the highest participation rate (95%). The main topics trained on shrimp farming households include Sustainable production standards (82%), Disease management in shrimp farming (68%), Adaptive farming to climate change (64%), Control Quality control of input products (41%), Effective feeding management (31%), Advanced techniques in shrimp farming (29%), New technology in farming (20%). For intensive shrimp farming households, the training topics that households are most interested in are Disease management in shrimp farming, Effective feeding management; Applying sustainability standards (over 90%) and farming to adapt to climate change. Most households said they have not participated in training courses on building business plans and financial management in shrimp production *(Details shows at table 17 in annex).*

Figure 23: Access to technical training (%)



For pangasius farming households in the survey sample, 86% of pangasius farming households interviewed said they had participated in at least one training course on pangasius farming techniques. The main training contents include: Disease management in pangasius farming (86%), Effective feeding management (80%), Applying sustainable standards (75%), Controlling the quality of first products input (60%), Farming to adapt to climate change (45%), Market requirements of shrimp/pangasius importing countries (43%). Most pangasius farming households said they have not participated in training courses on building business plans and financial management in pangasius production.

Figure 24: Farming standards/Certifications



Most shrimp and fish farming households in the survey sample said they apply sustainable farming standards. For shrimp farming households: 42% of shrimp farming associations apply ASC standards, 12% of shrimp farming associations apply GlobalGAP standards, 10% of shrimp farming households apply BAP standards, and 8% of shrimp farming households apply standards VietGAP.

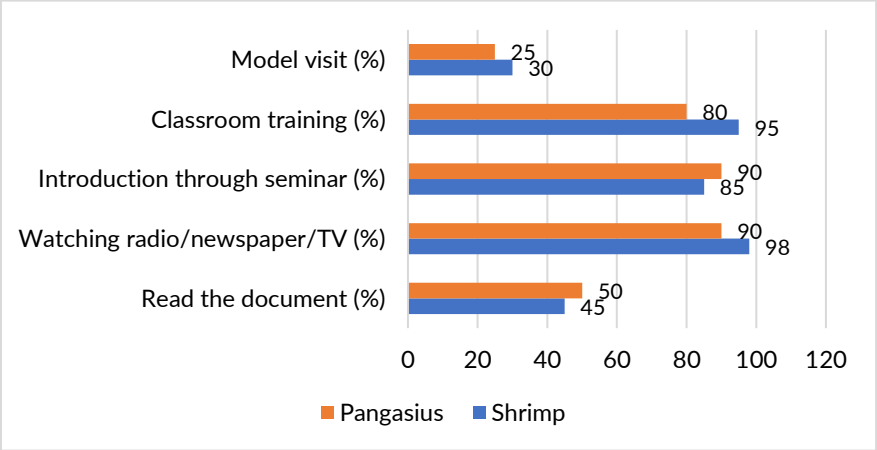
The rate of application of sustainable farming standards is high in intensive shrimp farming models (95%) and ecological shrimp farming (79%), while in semi-intensive farming models the rate of application of sustainable farming standards is high. This is only 18%. While most pangasius farming

households surveyed said they apply sustainable farming quality standards (91%). Pangasius farming households mainly apply VietGAP (84%) and ASC standards (6.8%), the remaining about 9% of pangasius farming households do not apply any technical standards *(Details shows at table 18 in annex).*

The **Fisheries Department is the unit that organizes most of the training courses for farmers**, along with the agricultural extension center and the cooperative alliance. In addition, the Fisheries Department also supports farmers in applying pond numbering and VietGAP certification for pangasius farming households. Companies provide additional training support for farming households when new products are available. **Each large feed, medicine and chemical company usually has 30 - 40 technical staff**, these staff also provide technical guidance to farmers based on observations from the pond field. Some companies also have labs and support free water and shrimp disease testing for farmers *(Details shows at table 19 in annex).*

Survey results of shrimp farming households showed that 98% of farmers interviewed accessed information through watching local television; 95% said they accessed information through training courses; 85% said they reached out through workshops. Some farmers access technical and commercial information through fairs and read documents themselves. In recent years, farmers like to share information through zalo groups, facebook, etc..*(Details shows at table 20 in annex).*

Figure 25: Forms of information access (%)



For the pangasius farming associations surveyed, **90% of pangasius farming households interviewed said they accessed information through watching local television**; 80% said they accessed information through training courses. Only 50% of pangasius farming households read and research documents themselves; There is a proportion of families visiting demonstration models and successful farming models to learn with the rate being 30% in shrimp and 25% in pangasius farming households.

2.8. Demand for production and market linkages

About 82% of small pangasius farming households said they do not participate in any local collaborative groups or cooperatives. Information sharing between households is mainly through the form of sharing experiences and information with each other in informal forms, such as clubhouses, which take place when farming households meet at coffee shops. **Decisions on farming investment time and farming season are mainly based on market demand and personal experience**.

Pangasius farming households are not affiliated with companies, but only have contracts committing to sell their fish to companies that stipulate fish size, time, residue, and harvest time; 98% of pangasius

farming households said they had signed purchasing contracts with companies and most of them complied with the quality conditions required by the businesses in the contract. For households that raise pangasius for processing companies; companies will invest in feed, while households invest in ponds, seed, and veterinary medicine. Some pangasius farming families have linkages with input supply agents to buy feed and veterinary medicine and pay later with agreed interest rates. Among the surveyed households, **98% of households raising pangasius to sell fish to processing enterprises**. Fish purchasing companies only pay about 10% when buying, the remaining 90% will be paid gradually to pangasius farming households within 1-2 months.

In the past 10 years, the pangasius industry has changed in structure. Companies want to ensure and to be proactively sourcing raw materials for processing and export; **Therefore, processing enterprises have built raw material areas for themselves, accounting for 65-70% of their raw material demand**.

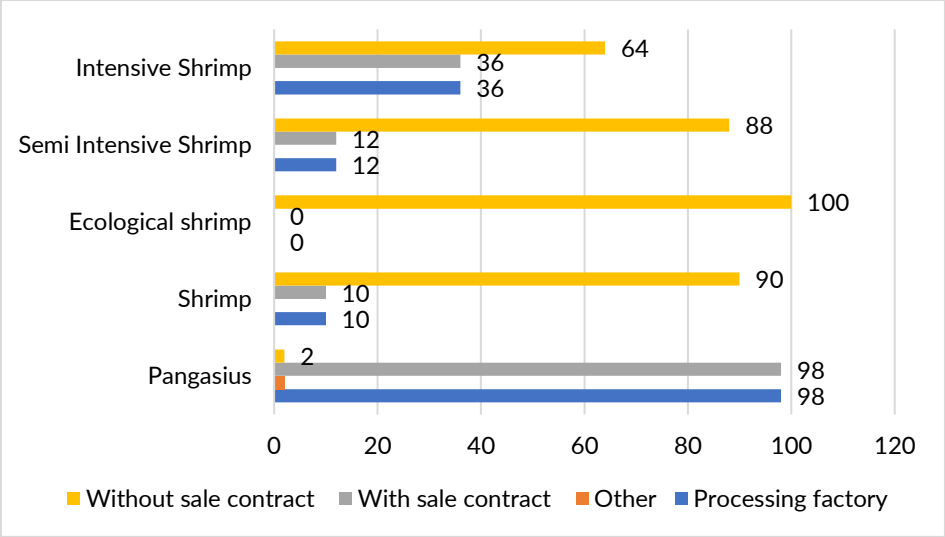
The raw material farming area is built on land owned by the companies, leased land to people or assigned to farmers to farm for processing in the form of providing feed, imposing FCR, and output with farming households. The remaining amount of pangasius raw materials is about 30 - 35%, companies will buy from small pangasius farming households outside in the form of signing direct purchasing contracts.

Table 02: Status of linkages (%)

Criteria	Shrimp (Average)	Ecological shrimp	Semi Intensive Shrimp	Intensive Shrimp	Pangasius
Participation in cooperatives/collective groups (%)	90	85	100	100	18
Not participating in cooperatives/ collective groups (%)	10	15	0	0	0
Affiliate participation (%)	41	26	30	95	0
- Linkage for buying/advancing seed (%)	4	2	6	0	0
- Linkage for buying/advancing feed (%)	4	0	6	22	0
- Linkage for buying/advancing drug and chemical (%)	2	2	0	5	0
- Linkage for selling product (%)	31	22	18	68	18

For shrimp farming households in the survey, 90% of small shrimp farming households interviewed said they participated in local cooperatives or cooperatives. Among semi-intensive and intensive shrimp farming households, this rate is 100%. Meanwhile, 41% of shrimp farming households surveyed said they had links with businesses, this rate in intensive farming households reached 95%. Among the popular links/contracts, they focus mainly on product sales and food advances. Regarding product consumption, 93% of farmers sell shrimp to traders and wholesalers in the province for processing enterprises in the form of payment upon sale. The rate of direct sales to processing companies is only 10% on average, with intensive farming households being 36% *(Details shows at table 22 in annex).*

Figure 26: Access to market (%)



In the survey sample, 90% of households said they had signed purchasing contracts with businesses and most complied with the quality conditions required by the businesses in the contract. The rate of signing consumption contracts is mainly in intensive farming households (36%), and the majority of production links follow ASC certification; Farming households can buy shrimp from businesses at a higher price of 2,000 VND/kg when ASC is available. The sources of shrimp raw materials for processing enterprises are quite diverse. Although the trend of developing farming areas to be self-sufficient in raw materials is relatively large, **the amount of raw materials from this source is only meeting about 14.6% of the processing plant's raw material needs**. The main source of raw materials for the enterprise is currently traders inside and outside the province with a total output of nearly 67.5% of the raw materials. Associated shrimp farming households are contributing about 12.3% to the total raw material needs of the business. However, buying through traders often has risks in production, antibiotic control, and product traceability.

PART 3. CONCLUSION AND RECOMMENDATIONS

3.1 Conclusions

3.1.1 Pangasius

The pangasius farming sector is stable in its farming area of 6000 ha, and has been **concentrating in its production scale with more than 70%** of pangasius areas are operated by large and well-off farmers and companies in the main pangasius farming provinces such as An Giang, Dong Thap and Ben Tre; and less than 30% of pangasius farm areas are still in operating by small-scale farmers in Vinh Long, Can Tho, and Hau Giang provinces. Pangasius farms require large investment in working capitals of about 27 billion VND/year, in which feed costs account for 84%, fingerling costs 7.5%, medicine and chemical 3%. Pangasius farms have to seek for bank loan to finance 57% of their total working capital with an interest rate of 8.4%/year. However, pangasius farming **profitability is only 5%/year**, equivalent to bank savings interest rate, showing that small-scale pangasius farms are operating close to its break-even points, and very vulnerable to price and market fluctuation risks.

Pangasius farms are supplied with deteriorating and poor-quality seed and fingerling, hence **survival rate is only 52.6%.** High rate of pangasius fingerling dead cost pangasius farmer more than 300 million VND/ha. Pangasius seed and fingerling are not certified and/or quarantined. Pangasius farmers have to pay promptly cash to fingerling supplier when purchasing seed. **Feed accounts for 84%** of pangasius production cost, and 81.8% pangasius farms buy feed from agencies with a deferring payment method. This means that pangasius farmers delay their feed payments to feed agencies and bearing a feed price of 25-30% higher compared to a immediate payment. **FCR in pangasius farming increases to 1.7-1.8** compared to 1.2-1.4 in the previous decades. Pangasius feed quality is under concern by farmers with indigestible protein contents, import-dependent feed ingredients, and increasing price set by feed producers and agencies.

Pangasius farms in the Mekong delta are employing very high production intensity, with high stocking density of 60 fingerling/m^2, stocking fish in deep and concrete ponds, with high level of water exchange daily. Pangasius farms are enhancing its **technological applications** in wastewater and sludge management (27%), fish disease prevention and treatment (16%), water environment stabilization bioproduct (16%), disinfection and water treatment (22%). Some few pangasius farms are applying technologies in feeding, fish population sampling and monitoring, IOT to help improving farm management. However, technological applications are limited in improving productivity, but not systematic improving the sustainable of the pangasius farming business.

The assessment indicates that pangasius farming sector remains problematic due to its **lack of cooperations among farmers, cooperatives, and processing facilities**; 82% of small-scale pangasius farming households said they do not participate in any local collaborative groups or cooperatives. Pangasius farmers access to information mainly through information sharing among pangasius farming households the forms of experience discussion and informal forms at community clubhouses. Pangasius farms have had participated in technical training on pangasius farming techniques such as disease management (86%), feeding management (80%), sustainable standards (75%), climate change adaptation (45%), market requirements (43%).

3.1.2 Shrimp

Shrimp farms are still mainly at small-scale and operating by smallholders in the Mekong delta with a shrimp farming area of less than 3 hectares/farm, accounting for more than 85% of shrimp farms. Only about 15% of shrimp farms in the Mekong delta are operated by large-scale farmers or companies. Shrimp farming is reported to be farmers' primary income of shrimp farming household, accounting for 77%-98%. Average income of a shrimp farm is 195 million VND/year, In which ecological shrimp farms is 102 million VND/year, semi-intensive shrimp farms 217 million VND/year, and intensive shrimp farms 452 million VND/year. Shrimp farming is a risky business but also highly profitability, with the ROI of about 27% on average, 66% for ecological shrimp, 34% for semi-intensive, and 21% for intensive shrimp farming.

Shrimp farms often have been built into several small-size ponds, 4.7 ponds/farm for intensive shrimp, 1.7 ponds/farm for semi-intensive, and 1.4 ponds/farm for ecological shrimp. The average size of a shrimp pond is about 2700m^2/pond for intensive, 1.3 hectares/pond for semi-intensive shrimp farm, and 1.5 hectares/pond for ecological shrimp. Shrimp stocking density is highly varying from 2-3 piece/m^2 for ecological shrimp, to 11 piece/m^2 in semi-intensive, and 160 piece/m^2 in intensive shrimp model. **Low shrimp survival rate** of only 15% at ecological shrimp, and about 50-55% for semi-intensive and intensive shrimp models. Shrimp farmers were trying new aquaculture techniques to improve shrimp survival rates by improving shrimp seed quality, by breaking shrimp farming into several culturing stages, or multi-stages shrimp farming.

Shrimp farms in the Mekong delta mainly buy seedling from two large companies, Viet-Uc and CP, accounting for about 60%: the remaining buy seedling from small seedling facilities and agencies from the Central region, such as Ninh Thuan and Binh Thuan provinces. Shrimp farms must pay cash immediately when purchasing shrimp seedling and cannot relying on credit for seedling. Most shrimp farms said reported that they buy shrimp seedling with quality certification. However, most are not confident about the quality of shrimp seeds. **All semi-intensive and intensive shrimp farms in the Mekong delta use industrial feed for their shrimp farming**. The average FCR in shrimp farms is 1.49. Nearly 68% of households buy food for farmers in the form of deferred payment or credit from feed agents; and will pay for feed after shrimp harvest. The proportion of semi-intensive shrimp farms buying feed on deferred payment is quite large, 88%; meanwhile, intensive shrimp farming 55%. **Shrimp farms that buy feed on credit paying 15-20%/3-6 months** in terms of higher feed prices.

There is a high demand for new technological applitions among shrimp farms in the Mekong delta. Ecological shrimps do not apply much new technologies yet, but **intensive and semi-intensive shrimp farms have been employing many new technologies**, such as water treatment technology (30%), biological products (30%), sterilization technology (20%), and antibacterial technology (20%), disease prevention and treatment technology (20%), gas and oxygen supplementation technology (15%), smart pond management technology (12%), closed farming technology (10%) and other technologies such as waste management, sludge settlement, feeding and harvesting technologies. Shirmp farms in the Mekong delta have a great need to access information and techniques, popular topics include i) apply sustainability standards (82%); (ii) disease management (68%); (iii) adapt to climate change (64%); (iv) quality control of input products (41%); (v) effective feeding management (31%); (vi) advanced techniques (29%); (vii) new technology (20%).

Besides its high profitability, **many problems are still existing in shrimp sector in the Mekong delta including small-scale and fragmented production, shrimp diseases, environment pollutions, and market risks**. Additionally, shrimp farms are facing difficulties in access to financial resources, so that meeting only 30 - 50% of total investment capital of shrimp farms.

Therefore, shrimp farms allow only small percentage of their investment on fixed and technilogical application, **less 1% of total shrimp farms' investments are allocated to long-term capital,** such as mechines and technologies to improve shrimp farming sustainability. Therefore, shrimp farms in the Mekong delta have high demand for loans.

The rate of shrimp farms **participating in cooperative linkages** is high (90%) among surveyed sample, among semi-intensive and intensive shrimp, this rate is 100%. However, the number of households trained on cooperative management and financial management still modest. The rate of households selling products directly to processing companies is still low (about 10%), shrimp farms mainly sell shrimp to local traders, so it is very difficult for processing factories to control the quality when purchasing and processing products. Hence, there is a need to strengthen the organization of shrimp value chains in the Mekong delta.

3.2 Recommendation

3.2.1 Pangasius

For further sustainable development of pangasius sector, we propose several recommendations on 5 key areas, including *(i) Tightening up the cooperation between cooperatives and enterprises; (ii) Improving the quality of pangasius broodstock and fingerlings; comprehensive and specific solutions for improvements of disease resistance and genetic breeding; (iii) More research on measures/intervention for cost-efficient feed; (iv) More research into sludge treatment to properly make better use of sludge (fertilizer); (v) Strengthening the application of IOT in farming to reduce labour costs. Specifically, as the following:*

1) **Promote the cooperative model and closer linkages between cooperatives and processing companies to better share risks and returns for farmers**. Cooperatives help farmers having stronger negotiating position in the value chain so they can better deal with market risks. Dutch experience and expertise will be certainly useful to pangasius famers in the Mekong delta in development a creative and smart cooperative model, that is suitable the characteristics and interests of pangasius farmers. Cooperative model will improve fish traceability and pangasius value chain structure.
2) **Improving the quality of pangasius broodstock and fingerlings is an urgent requirement that requires systematic investment by the state, long-term projects, and programs** to reduce the mortality rate of fish fingerlings, reduce fish disease rates and improve the efficiency of farming. There is need to promote private and public partnership in developing good broodstock selection program, quality and standard fry production procedure and fingerling nursery system. A private company specialised on producing good quality pangasius fingerling in the Mekong delta would be a great potential for the sector.
3) **Research is needed to reduce the amount of feed, solutions to supplement functional feeds, and improved farming systems to reduce the amount of feed use**. Quality feeds that are suitable for different stages of fish development and suitable for different product quality and market orientation are necessary. Alternative domestic feed ingredients could be an opportunity need to be look at and test. Feed that contributes to reduce CO_2 emission could be an option for the industry.
4) **Sludge is a big problem in the pangasius farming industry (6-10 tons/ha/crop).** This is a huge resource that **needs to be researched** to take advantage of and exploit value from mud, such as producing organic fertilizer and growing medium for plants. This intervention will help reducing negative impacts on environment.

5) **Applying IoT technology to monitor the environment, fish growth, and fish health** (flexibility, population distribution, fish size measurement, etc.) is a solution that needs to be strongly developed in the near future. This application will improve the efficiencies of the pangasius farming business.

3.2.2 Shimp

In the shrimp sector, several key recommendations for the sector to improve its current structure for a well-organized production, including: ***(i) Furthering technological application capacity, (ii) Facilitating farmers' access to finance to scale up their production, (iii) Allocating a bigger and concrete proportion of the total investment/harvest (or yearly) reserving for IT applications, (iv) Fostering a closer linkage between cooperatives and processing enterprises, (v) Strengthening government's role in monitoring and providing early warning solutions for better prevention of diseases***. *Details as below:*

1) **To promote the improvement of production capacity of shrimp farmers in terms of management capacity and application capacity of technologies and farming techniques are crucial**. Capacity building activities need to shift towards on-farm training, and making use of recent development of educational technological aids that are suitable to farmers and adult learning and practices.
2) **To promote shrimp farmers' access to bank loans through mortgage loans or value chain-based financing loans** to create conditions for households to expand their farming production scale. Better access to loan and investment money will help shrimp farmers easier to consolidate their production and to coping with production and market risk in the sector.
3) **Allocating a bigger and concrete proportion of the total investment reserving by shrimp farms for IOT applications.** Promote an increase in the proportion of advanced technology and techniques investment in the total investment structure to improve farming efficiency. Facilitating funding mechanism for advanced IOT application among shrimp farms should be in place to help improve the sector efficiencies.
4) **Develop and promote a closer linkage model between cooperatives and processing enterprises to support farmers in better access to quality seeds, feed and drugs to improve productivity and reduce investment costs**. Creative value chains model in shrimp sector is helpful to small-scale shrimp farms to better access to quality inputs and selling their products.
5) Finally, state management should be strengthened in monitoring and **in early warning of diseases occurring in aquaculture production regions**, and to promptly recommend and guide farmers to effectively prevent and treat shrimp diseases. Improvements in shrimp farming planning and infrastructure are needed to be in place for long-term and sustainable development of the sector.

REFERENCES

1. VIFEP, 2022, Investigate the current situation and determine the potential for developing aquaculture of potential aquatic species in the Mekong delta.
2. Nguyen Thanh Tung, VIFEP, 2015, Potential, current status, opportunities, challenges of Vietnam's fisheries industry.
3. Department of Fisheries, 2023, Promoting investment in aquaculture in the Mekong delta: Challenges and opportunities in the new context.
4. Department of Fisheries, 2023, Vietnam aquaculture statistical data 2008 - 2022.
5. Dinh Xuan Lap, ICAFIS, 2023, Promoting shrimp chain linkages/value chain in the Mekong delta - Lessons learned.
6. BCG, 2019, A Strategic Approach to Sustainable Shrimp Production in Vietnam.
7. VASEP, 2022, Statistical data on seafood export 2008 - 2022.
8. Department of Fisheries, 2023, Current status of aquaculture in Vietnam - orientation for the development of brackish water shrimp farming until 2030.
9. Ministry of Natural Resources and Environment (2016), Overview of challenges for the Mekong delta, Mekong delta Sustainable Development Conference (2016).
10. Summary report of year 1 and year 2 of the project "Developing a fair and sustainable shrimp value chain in Vietnam - SusV" (2016, 2017).
11. GRAISEA (2015), Initial assessment report of the Project "Enhancing gender equality in the shrimp value chain in Soc Trang province and investing in responsible agricultural business in Vietnam and Southeast Asia (GRAISEA))".
12. Directorate of Fisheries (2016), Report on Technical solutions and production organization for Aquaculture adapting to saline intrusion in the Mekong delta.
13. VIFEP (2010b), Analyzing the impacts of climate change on fisheries in Vietnam, proposing solutions and adaptive policies to cope with the impacts of climate change.
14. VIFEP (2012), Assessing vulnerability to climate change as a basis for developing effective policies and support activities for areas affected by climate change.
15. Vietnamese shrimp forum documents, 2023
16. Overview of the situation of processing and exporting freshwater shrimp in Vietnam, 2023, Department of Quality, Processing and Market Development.
17. Planning, Cooperation and Information Department, 2023, Report updating information on the pangasius industry.
18. Directorate of Fisheries, 2022, Results of pangasius production and consumption in 2021 and 2022.
19. Department of Fisheries, 2023, Development situation of pangasius industry.
20. VASEP, Pangasius industry report 2009 - 2018.

ANNEXES

Table 03: Aquaculture area in the Mekong Delta, 2015-2021

No	Province	2015		2020		20221		Growth rate (%/year)
		ha	(%)	ha	(%)	ha	(%)	
	Vietnam	**1.054,5**	**100**	**1.118,3**	**100**	**1.128,9**	**100**	**1,1**
	MRD	**758,6**	**71,9**	**801,3**	**71,7**	**811,6**	**71,9**	**1,1**
1	Long An	8,7	1,1	8,6	1,1	8,6	1,1	-0,2
2	Tien Giang	15,6	2,1	14,8	1,8	13,3	1,6	-2,6
3	Ben Tre	42,4	5,6	38,0	4,7	37,1	4,6	-2,2
4	Tra Vinh	29,5	3,9	41,5	5,2	40,4	5,0	5,4
5	Vinh Long	2,4	0,3	2,5	0,3	2,5	0,3	0,7
6	Dong Thap	5,1	0,7	5,7	0,7	6,2	0,8	3,3
7	An Giang	2,0	0,3	1,8	0,2	2,0	0,2	0,0
8	Kien Giang	136,2	18,0	171,5	21,4	183,6	22,6	5,1
9	Can Tho	10,7	1,4	6,5	0,8	6,0	0,7	-9,2
10	Hau Giang	6,8	0,9	8,1	1,0	8,1	1,0	3,0
11	Soc Trang	68,8	9,1	76,3	9,5	72,3	8,9	0,8
12	Bac Lieu	130,6	17,2	140,5	17,5	144,5	17,8	1,7
13	Ca Mau	299,8	39,5	285,5	35,6	287,0	35,4	-0,7

Source: MRD's Department of Fisheries, 2022

Table 04: Vietnam's shrimp export values, 2015-2020

No	Products/Export Market	2015		2020	
		Value (Million USD)	%	Value (Million USD)	%
I	**Shrimp Products**	**2.952**	**100**	**3.694**	**100**
1	Black Tiger *(Penaeus monodon)*	963	32,63	575	15,58
2	White leg (*P. vannamei)*	1.742	59,02	2.715	73,50
3	Other shrimp	247	8,36	10,92	10,34
II	**Export Market**	**2.952**	**100**	**3.694**	**100**
1	US	657	22,25	867	23,46
2	Japan	580	19,64	607	16,43
3	EU	549	18,58	516	13,98
4	China	254	8,61	412	11,15
5	Korea	251	8,50	340	9,20
6	Canada	139	4,69	187	5,07
7	Austraylia	107	3,64	154	4,18
8	Taiwain	64	2,17	50	1,35
9	Asean	55	1,87	43	1,17
10	Swiss	27	0,92	29	0,80
11	Middle Eastern countries	84	2,86	41	1,12
12	Other contries	185	6,26	447	12,09

Source: VASEP 2020

Table 05: Current status of pangasius exports, 2015-2020

No	Market	2015		2020	
		Value (Million USD)	Structure (%)	Value (Million USD)	Structure (%)
1	EU	287,30	16,79	125,70	8,03
2	America	315,50	18,44	246,50	15,75
3	ASEAN	135,40	7,91	133,60	8,54
4	China	161,50	9,44	487,60	31,15
5	Canada	37,20	2,17	30,30	1,94
6	Australia	36,10	2,11	32,20	2,06
7	Mexico	95,80	5,60	92,20	5,89
8	Colombia	58,50	3,42	33,40	2,13
9	Brazil	77,70	4,54	47,60	3,04
10	Middle East	169,10	9,88	62,20	3,97
11	Arab Saudi	61,50	3,59	0,10	0,01
12	UAE	28,60	1,67	26,40	1,69
13	Egypt	37,00	2,16	20,20	1,29
14	Israel	4,30	0,25	3,40	0,22
15	Lebanon	6,40	0,37	3,10	0,20
16	Japan	8,40	0,49	21,50	1,37
17	Other	190,90	11,16	199,30	12,73
	Total	**1711,20**	**100,0**	**1.565,30**	**100,0**

Source: VASEP, 2020

RESEARCH METHODS

Documents and data used in the report were collected using different methods such as desk research, in-depth interviews, structured questionnaire interviews, and group discussions.

Secondary desk study: This process is carried out by collecting, evaluating and analyzing available reports and reference documents, project documents provided by relevant parties in aquaculture in Vietnam and the Mekong delta. In addition, other reference documents about the shrimp industry, investigations of relevant actors and small-scale shrimp and pangasius farmers from relevant organizations/agencies are collected and analyzed.

In-depth Interview: In-depth interviews were conducted with relevant actors in both the private sector (collectors, traders/input and output businesses) and the public sector, such as the Department of Agriculture and Rural Development, local authorities (districts, communes, villages).

A set of in-depth interview guides was compiled, focusing on the different roles of these actors in the shrimp and pangasius industry chain. In-depth interviews help to better understand the trends in shrimp and pangasius production, water treatment, new technology, feed, breeds, chemicals and products, harvesting and processing, as well as financial access issues.

Structured-questionnaire interview: The questionnaire directly interviews actors in the value chain, including: collectors, traders, businesses and especially small-scale producers are deployed to collect detail information to support the data analysis process.

Focus group discussion: This activity is to ensure the suitability and consistency as well as the accuracy of the information and data collected. Structured questionnaire interviews and in-depth interviews are the main activities to collect primary data. Support the implementation of this method with a number of tools: *i) SWOT analysis of the shrimp industry locally as the basis for analysis for the report; ii) Problem tree analysis: Systematic analysis of prominent causes in local shrimp and pangasius production, aiming to find intermediate causes and specific causes (root causes) of problems, detect and handle the underlying causes that hinder the development of the local shrimp and pangasius industry, thereby building solutions in the target tree; iii) Venn diagram analysis: Identify the main organizations and individuals participating in the local shrimp and pangasius industry chain, and demonstrate the relationship and importance of these organizations for the development of the entire chain.*

Sampling method

Survey sites of pangasius farmers are in Vinh Long and Can Tho; Survey sites for shrimp farmers are in Bac Lieu and Ca Mau. In addition, traders in the survey area and shrimp and pangasius processing factories in some neighboring provinces purchase shrimp and pangasius such as Soc Trang, Can Tho, and Hau Giang.

Table 06: Number of survey samples

#	Interviewees	National	Can Tho	Vinh Long	Bac Lieu	Ca Mau
1	Input supplier		2			
2	Feed supplier		3			
3	Hatcheries		3			
4	Certifying bodies	3				
5	Smallholder pangasius farmers				52	51
6	Smallholder shrimp farmers		25	19		
7	Colletors/trader		2			
8	Processor		5		1	2
9	Association	1			1	1
10	University		1			
11	Research Institutes	3				
12	Training/extension				1	1
13	INGO	2				
14	National state's agencies	2				
15	Local state's agencies		3	2	2	2
16	Local authorities		5	5	5	5
Total		**11**	**49**	**26**	**62**	**62**

Farmer interview forms were prepared, tested, and edited before conducting official interviews. In addition, secondary data related to pangasius farming were also collected from the Department of Agriculture and Rural Development of the 4 surveyed provinces. After being collected, the data was checked, entered and processed. Descriptive statistical analysis method, testing the mean values (ANOVA) of main technical and economic variables, with significance level $\alpha = 5\%$ and multivariate regression correlation was used. via SPSS software (ver. 13)

The total number of households interviewed reached 147/160 households, of which the number of pangasius farming households participating in the interview was 44/40 households in 02 provinces of Vinh Long and Can Tho city. The number of shrimp farming households reached 103/120 households in 02 provinces of Bac Lieu and Ca Mau. In addition, the team also interviewed 63 relevant actors from businesses, local governments and service providers at district, provincial and central levels. The total number of samples participating in the interview reached 210/240 (87.5%).

Questionnaire development

The survey team develops different research tools to collect and gather information in aquaculture industry, on actors along aquaculture value chain, and aquaculture farmers.

- Checklist for aquaculture and fisheries expert interviews: information to be discussed are about aquaculture value chain, supportive services along the value chains, the role of institutional arrangements for aquaculture value chain, linkages along the aquaculture value chains, policies and regulations promoting aquaculture value chain, and opportunities for aquaculture value chain development.
- Questionnaires for input suppliers of seed, feed and chemical: types of business, operational capacity, products' specifications, distribution system, financial sources, market information, competition landscape, economic analysis and efficiencies, opportunities and challenges.
- Questionnaires for middlemen and processing plants: processing capacities, and processing products, raw material sources, loan and payment methods, market linkages, product consumption markets and demands, economic analysis and efficiencies, opportunities and challenges.
- Questionnaires for small-holder aquaculture farmers: farm resources information, production characteristics and criteria, technical production specifications, economic analysis and efficiencies, product consumption and markets, production linkages, input demand and access, financial need and access, technical and training need assessment, technological application and access, advantages and challenges.

Key information includes information on household economics, technical aspects of responsible aquaculture, technology, value chain approach, finance, etc. The team developed 04 types of questionnaires: *i) questionnaire for farming households; ii) questionnaire for traders; iii) questionnaire for processing plants; iv) questionnaire for state management agencies and experts.*

Excel template that serves as a comprehensive framework for organizing and analyzing the collected data was developed and used. This template included pre-defined indicators and key themes relevant to the study's objectives

User-friendly database forms for data entry was developed, ensuring they are accompanied by a code list for standardized data input. These forms has captured all the necessaryinformation while promoting data accuracy and consistency.

Finalize the data collection tools was finalized after conducting a pilot phase to ensure their effectiveness and make any necessary refinements. This step has involved incorporating feedback from the pilot study to enhance the tools' clarity and suitability. Thoroughly clean completed questionnaires, focus group discussion (FGD) and interview notes, ensuring that all data is properly organized and easily accessible. Additionally, upload notable quotes and insights onto a shared drive daily to facilitate knowledgesharing among the team

Data processing

Data cleaning: data collected are organized and cleaned to serve the analytical purposes. Data are cross checked with difference sources and in different perspectives to ensure the data quality and consistency.

Qualitative data: Qualitative data is processed through 3 steps: data entry, coding and analysis. The information in the in-depth interviews will be coded. The qualitative data will then be classified, according to the analytical objectives.

Quantitative data: A template is designed for data entry. Data is compiled before being entered into the computer. Cross-entry and cross-checking (minimum 20%) will be performed to check consistency and avoid errors during data entry. After completing the data entry, the data are transferred to SPSS software for analysis.

Table 07: Aquaculture household characteristics

Criteria	Shrimp (Average)	Ecological shrimp	Semi Intensive Shrimp	Intensive Shrimp	Pangasius
Family size (persons)	4,5	4,4	4,4	4,8	4,20
Number of people involved in pangasius farming (person)	2,1	2,1	2,1	2,1	1,70
Household's income in 2022 (VND)	195,6	101,7	216,9	452,0	1.464,51
Income from shrimp/pangasius farming (%)	82,7	79,0	76,8	98,2	90,68
Farming based on experience (%)	60,00	70,00	65,00	55,00	50%
Have a degree in farming techniques (%)	40,00	30,00	35,00	45,00	50%
Farming experience (years)	18,5	20,6	18,6	12,4	16,20

** Note: Ecological shrimp: extensive shrimp, wild shrimp, rice shrimp.*

Table 08: Aquaculture production scale

Criteria	Shrimp (Average)	Ecological shrimp	Semi Intensive Shrimp	Intensive Shrimp	Pangasius
Number of ponds	2,15	1,39	1,71	4,68	3,61
Average farming areas (ha)	2,62	2,80	2,83	1,95	3,14
Actual farming areas (ha)	2,00	2,17	2,31	1,26	2,24
Actual output in 2022 (tons)	5,50	0,58	2,32	22,26	1.021,16

Table 09: Aquacultura production criteria

Criteria	Shrimp (Average)	Ecological shrimp	Semi Intensive Shrimp	Intensive Shrimp	Pangasius
Farming time (month/year)	8,78	10,25	6,76	6,05	9,8
Number of farming crops in a year (crops)	1,76	1,70	1,06	2,45	1,0
Farming cycle (day/crop)	199,32	227,66	195,88	119,55	293,9
Stocking density (Fingerling /m2)	37,43	2,58	10,88	159,32	59,3
Average survival rate (%)	29,21	14,83	50,88	54,32	52,6
FCR	1,49	-	1,51	1,48	1,7
Harvested size (g/fish-shrimp)	38,33	30,00	50,00	35,00	1.000,0
Productivity (Tons/ha/year)	2,10	0,21	0,82	11,42	325,0

Table 10: Aquaculture cost and benefit analysis (1000 VND/farm/year)

Criteria	Shrimp (Average)	Ecological shrimp	Semi Intensive Shrimp	Intensive Shrimp	Pangasius
I. Fixed costs					
- Land rent	-	-	-	-	90.159
- Initial investment costs	-	-	-	-	-
+ Earthworks for ponds/lagoons	2.858	1.481	3.000	5.632	43.636
+ Water supply and drainage	669	546	1.111	685	12.345
+ Pump	377	55	51	1.565	18.943
+ Generator	589	-	-	2.760	463
+ Fan system	405	-	54	1.856	-
+ Bottom aeration system	493	-	-	2.310	-
+ Secondary construction system	1.043	-	-	4.886	-
II. Variable costs					

Criteria	Shrimp (Average)	Ecological shrimp	Semi Intensive Shrimp	Intensive Shrimp	Pangasius
- Feed	267.729	-	148.150	1.138.979	22.535.459
- Seed	96.152	11.946	38.570	385.611	2.033.469
- Drug and chemical	32.160	8.124	37.647	97.840	791.538
- Gasoline, oil and electricity	25.587	46	4.382	116.272	248.500
- Loan interest payments	10.122	796	1.623	43.818	544.668
- Packaging, materials	-	-	-	-	-
- Dredging, desludging, and renovation	18.375	11.885	26.764	30.772	164.954
- Transportation costs	58	58	-	-	212.282
- Hired labor	13.378	-	5.411	58.454	265.886
III. Total cost (VND/ha/crop)	**470.001**	**34.942**	**266.768**	**1.891.448**	**26.962.306**
IV. Revenue (VND/ha/crop)	**640.350**	**103.751**	**406.647**	**2.381.954**	**28.004.659**
V. Profit (VND/ha/crop)	**170.349**	**68.809**	**139.878**	**490.506**	**1.042.352**

Table 11: Aquaculture cost and benefit structure (Unit: %)

Criteria	Shrimp (Average)	Ecological shrimp	Semi Intensive Shrimp	Intensive Shrimp	Pangasius
I. Fixed costs	**1,37**	**5,96**	**1,58**	**1,04**	**0,61**
- Land rent					0,33
- Initial investment costs					
+ Earthworks for ponds/lagoons	0,61	4,24	1,12	0,30	0,16
+ Water supply and drainage	0,14	1,56	0,42	0,04	0,05
+ Pump	0,08	0,16	0,02	0,08	0,07
+ Generator	0,13			0,15	0,00
+ Fan system	0,09		0,02	0,10	
+ Bottom aeration system	0,10			0,12	
+ Secondary construction system	0,22			0,26	
II. Variable costs	**98,63**	**94,03**	**98,42**	**98,96**	**99,39**
- Feed	56,96		55,54	60,22	83,58
- Seed	20,46	34,19	14,46	20,39	7,54
- Drug and chemical	6,84	23,25	14,11	5,17	2,94
- Gasoline, oil and electricity	5,44	0,13	1,64	6,15	0,92
- Loan interest payments	2,15	2,28	0,61	2,32	2,02
- Packaging, materials					
- Dredging, desludging, and renovation	3,91	34,01	10,03	1,63	0,61
- Transportation costs	0,01	0,17			0,79
- Hired labor	2,85		2,03	3,09	0,99

Criteria	Shrimp (Average)	Ecological shrimp	Semi Intensive Shrimp	Intensive Shrimp	Pangasius
III. Total cost (VND/ha/crop)	**100,00**	**100,00**	**100,00**	**100,00**	**100,00**
IV. Revenue (VND/ha/crop)	**136**	**297**	**152**	**126**	**104**
V. Profit (VND/ha/crop)	**36**	**197**	**52**	**26**	**4**

Table 12: Access to aquaculture feed

Criteria	Shrimp (Average)	Ecological shrimp	Semi Intensive Shrimp	Intensive Shrimp	Pangasius
Homemade feeds (%)	-	-	-	-	2.3
Industrial feed (%)	100,00	-	100,00	100,00	100,00
FCR	1,49	-	1,51	1,48	1.67
Form of payment for feed					
- Prompt payment (%)	23,67	-	0	31,00	13,6
- Payment in part (%)	8,67	-	12,00	14,00	4,5
- Deferred payment (%)	67,67	-	88,00	55,00	81,8

Table 13: Access to drug and chemicals (%)

Criteria	Shrimp (Average)	Ecological shrimp	Semi Intensive Shrimp	Intensive Shrimp	Pangasius
Buying source					
- Local agent (%)	85	78	100	100	91
- Company (%)	15	22	0	0	9
Payment method					
- Prompt payment (%)	75	80	82	50	41
- Payment in part (%)	3	0	3	5	6
- Deferred payment (%)	22	20	15	45	53

Table 14: Access to new technology (%)

Criteria	Shrimp	Pangasius
New technology in farming (RAS, Biofloc.....)	10,00	2,3
Microbiological treatment technology and biological products	30,00	15,9
Water treatment technology	30,00	11,4
Antibacterial technology	20,00	11,4
New technology in disease prevention and treatment	20,00	15,9
New feed	10,00	50,0

Criteria	Shrimp	Pangasius
Smart technology in pond management	12,00	4,5
Oxygen supply system in farming	15,00	6,8
Technology to support harvesting	5,00	9,1
New technology in renewable energy (solar power, wind power)	5,00	-
Technology for wastewater and waste treatment	16,00	27,3

Table 15: Technology introduction sources (%)

Criteria	Technology introduction units				
	Fisheries Department	Extension	Coop	Companies	NGOs
Shirmp					
New technologies in farming (RAS, Biofloc .....)	5,00	-	-	2,00	1,00
Microbiology treatment technology, probiotics	20,00	5,00	1,00	1,00	-
Water Treatment Technology	20,00	5,00	1,00	1,00	-
Bactericidal technology	10,00	2,00	2,00	1,00	-
Emerging Technologies in Infectious Disease Treatment, Prevention and Control	15,00	5,00	1,00	1,00	-
Emerging feed	1,00	1,00	-	5,00	-
Smart technology in aquaculture management	6,00	1,00	1,00	2,00	-
Oxygen supply system in culture	5,00	1,00	4,00	1,00	1,00
Assistive technology for harvesting	5,00	-	2,00	1,00	-
New technologies in renewable energy (solar power, wind power)	1,00	-	-	2,00	1,00
Technology for wastewater and waste treatment	10,00	5,00	1,00	1,00	-
Pangasius					
New technologies in farming (RAS, Biofloc .....)	2,3	-	-	-	-
Microbiology treatment technology, probiotics	13,6	-	-	2,3	-
Water Treatment Technology	9,1	-	-	2,3	-
Bactericidal technology	9,1	-	-	2,3	-

Criteria	Technology introduction units				
	Fisheries Department	Extension	Coop	Companies	NGOs
Emerging Technologies in Infectious Disease Treatment, Prevention and Control	15,9	-	-	2,3	-
Emerging feed	4,5	-	-	43,2	-
Smart technology in aquaculture management	2,3	-	-	2,3	-
Oxygen supply system in culture	4,5	-	-	2,3	-
Assistive technology for harvesting	6,8	-	-	4,5	-
New technologies in renewable energy (solar power, wind power)	-	-	-	-	-
Technology for wastewater and waste treatment	20,5	-	-	4,5	-

Table 16: Determinants of technology adoption (%)

Criteria	Shrimp	Pangasius
Techical capacity	12	25
Know-how on technology	30	45
Cost of technology	0	0
Investment capacity	10	35
Market incentives (income)	0	5

Table 17: Demand and access to working capital (%)

Criteria	Shrimp (Average)	Ecological shrimp	Semi Intensive Shrimp	Intensive Shrimp	Pangasius
Equity capital (%)	73	83	82	36	43
Borrowed capital (%)	27	17	18	64	57
Bank loan (%)	27	17	18	64	100
Private loan (%)	0	0	0	0	0
Agent loan (%)	0	0	0	0	0
Loan period (month/year)	10,8	12,6	8,7	9,9	10
Average interest rate (%/month)	7,5	8,3	7,3	6,9	8.4
Loan capital to meet investment needs (%)	39,5	50,0	40,0	31,1	45

Table 18: Access to technical training (%)

Criteria	Shrimp (Average)	Ecological shrimp	Semi Intensive Shrimp	Intensive Shrimp	Pangasius
Have attended training course (%)	83	86	65	91	86
Leadership capacity of the cooperative management	4	3	0	9	0
Financial management and capital mobilization capacity for cooperatives	4	3	0	9	0
Formulation of operation regulations of cooperatives	5	5	0	9	0
Building production and business plans	5	5	0	9	2
Chain management and market access	11	6	12	23	12
Disease management in shrimp/Pangasius aquaculture	68	64	45	90	86
Quality control of input products	41	33	35	64	60
Control and efficient use of water resources	23	17	12	50	45
Effective feeding management	31	11	24	91	80
Advanced techniques in shrimp farming	29	16	35	64	7
Efficient use of electrical energy	16	6	0	55	18
Adopt sustainability standards	82	85	65	91	75
New technologies in farming	20	10	18	55	14
Climate change adaptation farming	64	81	35	77	45
Market requirements of shrimp/pangasius importing countries	10	2	6	36	43

Table 19: Farming standards/ Certifications

Criteria	Shrimp (Average)	Ecological shrimp	Semi Intensive Shrimp	Intensive Shrimp	Pangasius
- Without standard (%)	27	21	82	5	9,1
- With standards (%)	73	79	18	95	90,9
+ VietGap (%)	8	3	0	28	84,1
+ ASC (%)	42	48	18	40	6,8
+ GlobalGAP (%)	12	20	0	0	-
+ BAP (%)	11	8	0	27	-

Table 20: Training providers (%)

Criteria	Technology introduction units									
	Fisheries Department		Extension		Coop		Companies		NGOs	
	S	P	S	P	S	P	S	P	S	P
Leadership capacity of the cooperative management	2,0	0,0	1,0	0,0	0,0	0,0	0,0	0,0	1,0	0,0
Financial management and capital mobilization capacity for cooperatives	1,0	0,0	1,0	0,0	1,0	0,0	0,0	0,0	1,0	0,0
Formulation of operation regulations of cooperatives	2,0	0,0	1,0	0,0	1,0	0,0	0,0	0,0	1,0	0,0
Building production and business plans	1,0	0,0	1,0	0,0	1,0	0,0	0,0	5	1,0	0,0
Chain management and market access	10,0	10,0	5,0	0,0	0,0	0,0	0,0	5	0,0	0,0
Disease management in shrimp/Pangasius aquaculture	40,0	82,0	10,0	0,0	1,0	0,0	0,0	5	0,0	0,0
Quality control of input products	30,0	65,0	10,0	0,0	1,0	0,0	0,0	5	0,0	0,0
Control and efficient use of water resources	12,0	40,0	8,0	0,0	0,0	0,0	0,0	5	0,0	0,0
Effective feeding management	20,0	73,0	10,0	0,0	3,0	0,0	0,0	7	0,0	0,0
Advanced techniques in shrimp farming	20,0	7,0	7,0	0,0	4,0	0,0	0,0	0,0	0,0	0,0
Efficient use of electrical energy	10,0	10,0	2,0	0,0	3,0	0,0	0,0	2	5,0	0,0
Adopt sustainability standards	70,0	60,0	10,0	0,0	5,0	0,0	0,0	15	1,0	0,0
New technologies in farming	15,0	10,0	5,0	0,0	2,0	0,0	0,0	2	0,0	0,0
Climate change adaptation farming	60,0	45,0	10,0	0,0	1,0	0,0	0,0	0,0	0,0	0,0
Market requirements of shrimp/pangasius importing countries	10,0	43,0	0,0	0,0	0,0	0,0	0,0	2	0,0	0,0

Note: S-Shrimp; P- Pangasius.

Table 21: Forms of information access (%)

Criteria	Shrimp	Pangasius
Read the document (%)	45,00	50,0
Watching radio/newspaper/TV (%)	98,00	90,0
Introduction through seminar (%)	85,00	90,0
Classroom training (%)	95,00	80,0
Model visit (%)	30,00	25,0
Participation in fairs (%)	-	-

Table 22: Product consummption llinkages (%)

Criteria	Shrimp (Average)	Ecological shrimp	Semi Intensive Shrimp	Intensive Shrimp	Pangasius
Traditional markets	0	0	0	0	0
Dealer and trader					
- Inside province	93	100	88	86	0
- Outside province	0	0	0	0	0
Processing factory	10	0	12	36	98
Other	0	0	0	0	2
Payments					
- Prompt payment (%)	100	100	100	100	10
- Payment in part (%)	0	0	0	0	90
- Deferred payment (%)	0	0	0	0	0
With sale contract	10	0	12	36	98
Without sale contract	90	100	88	64	2
Meeting the requirements of the buyer (%)	100	100	100	100	100
Not meeting buyer's requirement (%)	0	0	0	0	0
There is competition when selling products (%)	95	90	100	100	
No competition when selling products (%)	5	10	0	0	36