

CURRENT STATUS AND PROSPECTS OF SUSTAINABLE CLAM FARMING DEVELOPMENT IN VIETNAM

Mai Van Tai¹*, Phan Thi Van¹, Dang Thi Lua¹,
Nguyen Thi La¹, Vu Ngoc Lien¹, Pham Anh Tuan²

ABSTRACT

This paper presents a comprehensive assessment of clam farming in Vietnam, focusing on *Meretrix lyrata* and *M. meretrix* species. The study assesses the current state of seed production technology, commercial farming, and its integration with processing and product commercialization. Clam farming plays a significant role in Vietnam's mollusc sector, with a vast farming area of 17,730 hectares and a total clam production of 236,463 tons. The country has successfully exported these clams to 42 countries, amounting to a total value of USD 107.121 million. The methods section describes the data collection process, including field surveys, interviews with stakeholders, and policy analysis. The results and discussion section presents key findings related to seed production, commercial farming, and cooperation among stakeholders. Challenges in the industry, such as insufficient seedling supply, unclear land use, limited access to technology and capital, market issues, and environmental concerns, are identified. The paper concludes by emphasizing the potential for sustainable clam farming and the need for research and cooperation to overcome challenges and foster the sector's future sustainable development.

Keywords: *Clam farming, Vietnam, sustainable development, challenges.*

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1. INTRODUCTION

Clam farming is a thriving marine aquaculture sector in Vietnam, thanks to its extensive coastline, numerous river mouths, vast tidal flats (660,000 hectares), and diverse species (2,200 identified). Notably, *Meretrix lyrata* (Ben Tre clam) and *M. meretrix* are key species. Vietnam has made significant strides in clam farming, advancing seed production, commercial farming, and integrating processing and product marketing. Coastal provinces like Hai Phong, Thai Binh, Nam Dinh, Ninh Binh, Thanh Hoa, Ben Tre, Tien Giang, Tra Vinh, Soc Trang, and Kien Giang have established productive farming areas. In 2021, Vietnam's clam farming accounted for 50% of mollusc aquaculture (17,730 hectares) and 50% of total aquaculture production (236,463 tons). Additionally, it contributed a remarkable 86% to mollusc aquaculture exports [1].

Clam farming's significance is prominently underscored in various strategic documents, notably Decision 339/QĐ-TTg [2], which is elaborated upon in Decision 1664/QĐ-TTg [3], focusing on advancing marine aquaculture through 2030 and projecting targets until 2045. These directives set forth clear objectives for mollusk clam cultivation. The primary goal is to attain a production volume of 460,000 tons by 2025, with an additional increase to 550,000 tons by 2030 in coastal areas.

Clam farming has made considerable progress in both seed and commercial farming technologies. For instance, Ben Tre and Tien Giang provinces primarily rely on natural clam seed sources with low densities, while the Northern provinces employ artificial clam seed sources with higher densities and productivity [1]. Mechanization has also been introduced in the production process, including breeding area transformation, harvesting, and sorting.

¹ Research Institute for Aquaculture No.1

² Vietnam Fisheries Society (VINAFFIS)

* Email: maivantai@ria1.org

The success of clam farming also hinges on the adoption of good practices in commercial clam farming, which enhance productivity and the quality of farmed clams. Community-based and collective production management models have been established in certain regions, such as cooperative models in Ben Tre and Nam Dinh provinces, alongside individual and corporate models. Many unregistered clam farming cooperatives have collaborated in production and business activities. Several enterprises have invested in modern processing facilities for clam exportation, such as the clam processing plant by HASUVIMEX in Thanh Hoa, FAQUIMEX in Ben Tre [4].

To ensure sustainable development in the clam farming sector, further research and assessment are needed on the success and coexistence of different production models in different regions. Sharing experiences, technology, and resources will enable the adoption of best practices and foster sustainable development within the industry.

Despite the potential for substantial growth, clam farming faces various challenges. Ensuring the quality of raw materials, processing, and product consumption, as well as environmental management, food safety, genetic deterioration, and land use management, are critical issues that need to be addressed to ensure the sustainable development of the sector.

Despite facing various obstacles, clam farming in Vietnam holds substantial potential for achieving sustainable development. To unlock this potential, it is essential to conduct a thorough assessment of the industry's current state, explore possibilities for technological advancements, optimize production organization, and consider relevant policies. By identifying and addressing challenges and proposing effective solutions, we can pave the way for the future growth of clam farming in the country and ensure its long-term sustainability.

2. METHODS

Research Duration and Locations: The investigation spanned a duration of seven months,

commencing from January and culminating in July 2023.

Data Collection and Assessment: The study revolved around the compilation and meticulous analysis of an array of reports and documents pertinent to diverse dimensions of clam farming, processing, and consumption.

Field Surveys and Interview Methodology: The research was underpinned by a comprehensive approach that amalgamated both on-site surveys and insightful interviews. The geographical scope encompassed two distinctive regions: a concentration on Ben Tre in the southern region and an exploration of Thanh Hoa, Ninh Binh, Nam Dinh, and Thai Binh in the northern region. A total of 68 individuals were engaged in interviews, representing a diverse cross-section of stakeholders within the clam industry. The categorization of interviewees unveiled a composition of 79 people including 40 interviewees were farmers and traders representing cooperatives and associations, 9 interviewees affiliated with processing plants, 25 local officials, and 5 researchers.

- Ben Tre (22 interviewees): Department of Fisheries (2 interviewees); clam cooperatives including Rang Dong (5 interviewees), Dong Tam (4 interviewees), Tan Thuy (3 interviewees), An Thuy (4 interviewees), and Thanh Loi (6 interviewees).

- Thanh Hoa (28 interviewees): Department of Agriculture and Rural Development in Hau Loc District (4 interviewees); Association of Clam Production and Trade of Hau Loc (5 interviewees); Agriculture Research Institute of Thanh Hoa (5 interviewees); Thanh Hoa Seafood Import, Export Jsc - HASUVIMEX (9 interviewees) and Department of Fisheries (6 interviewees).

- Ninh Binh (5 interviewees): Kim Son Clam cooperative (5 interviewees); Department of Fisheries (2 interviewees).

- Nam Dinh (11 interviewees): Nghia Hung Clam cooperative (4 interviewees); Department of Fisheries (7 interviewees).

- Thai Binh (7 interviewees): Thuy Truong Clam cooperative (4 interviewees); Department of Fisheries (3 interviewees).

Expert interviews through semi-structured questionnaires were conducted, involving six experts from NGOs and associations: Center for Technology Transfer and Community Development in Agriculture and Fisheries - FACOD (2 experts), Ben Tre Fisheries Association (1 expert), International Cooperation for Sustainable Aquaculture and Fisheries Development - ICAFIS (1 expert), and Vietnam Association of Producers and Processors - VASEP (2 experts).

Focus Group Discussions were held with officers from the Ministry of Agriculture and Rural Development, totaling 17 participants. They represented the Department of Science, Technology and Environment (6 participants), Department of Fisheries (10 participants), and Vietnam Institute of Fisheries Economics and Planning - VIFEP (1 participant).

The profile of interviewees and participants in group discussion were meticulously crafted to

encompass a varied spectrum of professionals extensively involved in the clam industry, spanning policy makers, local officers, clam farmers, traders, processors and members of clam cooperatives or associations. The primary aim was to gather viewpoints from various stakeholders deeply engaged in diverse aspects of clam cultivation, processing, and distribution.

3. RESULTS AND DISCUSSION

3.1. Seed production

3.1.1. Seed demand

Every year, the nationwide demand for clam seedlings is estimated at 70 billion. However, the current total production of clam seedlings, originating from artificial reproduction, is only around 15 - 20 billion per year, meeting approximately 30 - 40% of the seedling demand for commercial farming. The seedling production is concentrated in facilities located in provinces like Nam Dinh, Thai Binh, Ninh Binh, Tien Giang, and Ben Tre, while the remaining supply mainly relies on natural exploitation [5, 6].

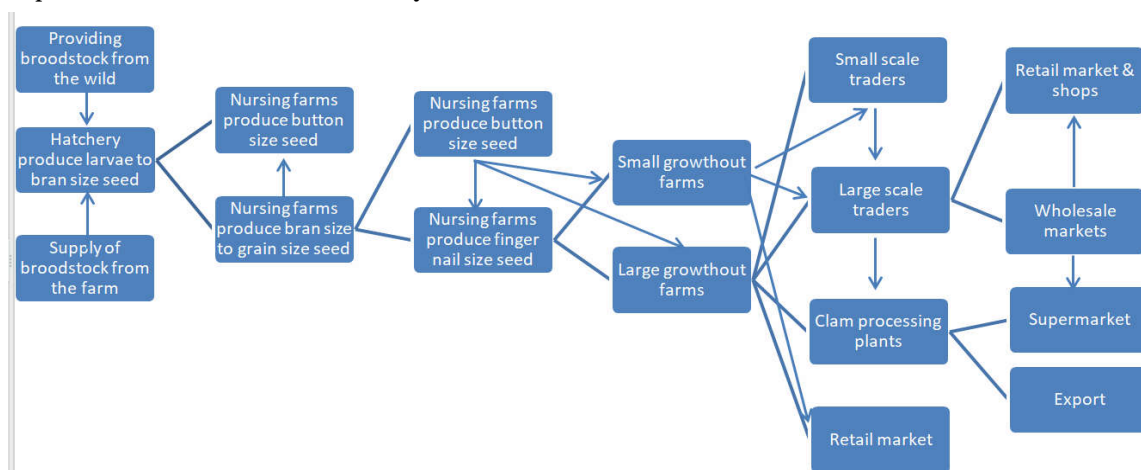


Figure 1. Value chain of clam in northern provinces of Vietnam.

Seed is nursed to different sizes for different growout practices

The increasing clam seedling demand has led to scarcity issues in most regions across the country, causing instability in clam farming. Currently, the primary source of clam seedlings is from natural extraction, which has limitations to meet the significant demand in provinces like Bạc Liêu, Tra Vinh, Ben Tre, and Tien Giang, where

the demand reaches billions of clams. In the northern clam farming regions, spanning over 5,000 hectares from Quảng Ninh to Hà Tĩnh, the primary source of clam seedlings is local artificial reproduction facilities, but they cannot fully meet the local farmers' demand. Consequently, some traders from Thanh Hoa and Nam Dinh have to

travel to southern provinces like Tien Giang and Ben Tre to purchase clam seedlings at higher prices and sell them to farmers in their regions [5,6].

In response to the seedling scarcity, some regions in Nam Dinh, Thai Binh, and Ninh Binh are developing clam seedling nursing. They start with clam seeds and grow them to larger sizes in order to supply other regions. The formation of clam seedling farming could alleviate the seedling shortage and enhance the availability of quality clam seedlings for sustainable clam farming across the country [1, 6, 7].

3.1.2. Natural seed exploitation

In the southern region, the actual exploitation and natural distribution area of clams covers approximately 12,000 hectares along the coastal areas from Can Gio district (Ho Chi Minh city) to Ca Mau province, with the most concentrated areas being in Tien Giang, Ben Tre, and Tra Vinh provinces [8]. A total of 493 hectares were established by 7 clam harvesting cooperatives, including: Rang Dong and Dong Tam clam cooperatives in Binh Dai district; An Thuy, Tan Thuy, and Bao Thuan clam cooperatives in Ba Tri district; and Thanh Loi, Binh Minh clam cooperatives in Thanh Phu district [9]. The natural seed sources of clams appear irregularly every year, with unstable production and uneven sizes of seeds. Seed size smaller than 5000 pieces per kilogram is not allowed to be sold out of Ben Tre province without permission of People Committee's of Ben Tre [10].

3.1.3. Seed production and research

Since 2003, the Research Institute for Aquaculture No.1 and No. 2 (RIA1 and RIA2) in Vietnam have been actively engaged in artificial reproduction technology for clams (*Meretrix* sp.). The successful implementation of this technology has resulted in notable technical achievements, including an impressive 80% participation rate of clams in the reproductive process, a remarkable 95% fertilization rate, and a promising 8 - 10% survival rate of first-stage seedlings, measuring 1mm in size [11]. The annual reproductive season

of the Ben Tre clam is determined from mid-April to the end of August. The main reproductive season occurs from mid-May to the end of July [12]. These achievements demonstrate the significant progress made in advancing clam reproduction techniques, contributing to the sustainable development of the clam farming industry in various coastal regions. The production facilities for clam seedlings are also used to produce other mollusk species such as ark shells, limpets, Pacific oysters, clams, and blood cockles, with seasonal adjustments. There are over 400 production and business facilities for mollusk including clam seedlings nationwide, mainly concentrated in provinces such as Quang Ninh (8 facilities), Hai Phong (2 facilities), Thai Binh (14 facilities), Nam Dinh (120 facilities), Ninh Binh (276 facilities), Nghe An (2 facilities), and Ben Tre (9 facilities). The annual production capacity exceeds 13 billion seedlings, meeting over 60% of the demand. The remaining seedlings are collected from natural sources for commercial farming, mainly in provinces like Ben Tre, Tra Vinh, and Tien Giang [1].

However, the current scale of clam seedling production, as well as mollusk seedlings in general, in Vietnam mainly takes place in small-scale hatcheries, where the broodstocks used for seedling production are not subject to selection and screening processes. They are often chosen from commercially farmed clams for reproduction, resulting in inconsistent seedling quality, slow growth, low meat content, and susceptibility to diseases. Furthermore, the current seedling production technology is limited by its dependence on the amount of food (phytoplankton) cultured in bags or tanks with low and unstable densities, leading to frequent shortages. Moreover, the operational cost per batch of larval rearing is high due to the large volume of water required for the larval culture process. Another technological limitation is that most mollusk hatcheries, particularly clam hatcheries, do not pay enough attention to the larval rearing and adaptation of seedlings to the natural environment before being transferred to

commercial farming areas, resulting in low survival rates of seedlings after release. The high production cost while recent selling prices have decreased considerably has led to reduced profits for seedling producers, and the practice of releasing clams at high densities in commercial farms slows down clam growth.

In the 2025 - 2030 Seed program (initially the 2022 - 2025 period) of the Ministry of Agriculture and Rural Development, the priority is given to the seed development of mollusks, including bivalve, clams, oysters, and scallops, which are considered as the main mollusc target for export.

3.2. Commercial Farming

3.2.1. Area and production

Clam production in Vietnam has a rapid growth. In 1998, farmers in Nam Dinh province conducted an experiment of transferring clam seeds from Ben Tre to be farmed in intertidal areas, and achieved good results [5, 7]. In the past decade (2010 - 2021) clam farming area increased by 20%, clam production increased by 120%, export value from clam increased by 276%. The current status of clam production and consumption in Vietnam in the period 2010 - 2021 [1] is summarized in table 1.

Table 1. Status of mollusk and clam farming and exporting in Vietnam in the period 2010-2021

Targets	2010	2015	2019	2021
1. Cultivation area (ha)				
Total molluscs	25,560	40,685	41,500	35,570
Clam	14,760	18,720	19,200	17,729
Percentage (%)	58%	46%	46%	50%
2. Output (tons)				
Total molluscs	135,011	26,531	310,000	471,669
Clam	109,250	18,691	226,944	236,463
Percentatge	81%	70%	73%	50%
3. Export output (tons)				
Molluscs	23,705	32,500	41,100	87,700
Clam	17,755	23,150	30,300	78,000
Percentatge	75%	71%	74%	89%
4. Export value (x 1,000 USD)				
Molluscs	57,677	82,390	93,642	125,095
Clam	38,765	57,000	63,000	107,121
Percentatge	67%	69%	67%	86%

Source: DFISH (2022) [1]

In recent years, the mollusk farming industry in our country has experienced strong development, primarily focusing on two main species: Clams (*Meretrix* spp.) and *Crassostrea* sp. This industry is concentrated in coastal provinces, including Quang Ninh, Thai Binh, Nam Dinh, Ninh Binh, Thanh Hoa, Nghe An, Ha Tinh, Ben Tre, and Tra Vinh. In recent years, the production, exploitation, and processing of clams have gradually become an important livelihood for people in coastal areas. Commercial clam farming has played a significant role in economic development, contributing to poverty reduction and notably improving the lives of people in these coastal regions [1, 6, 7].

3.2.2. Farming technologies

There are significant differences in clam farming technology between the Northern and Southern regions, concerning seed sources, stocking densities, productivity, and harvesting practices.

In the Southern region, clam farming for commercial purposes mainly relies on natural seed sources, especially from natural clam populations in Ben Tre province. However, some large-scale farms have recently started using artificially reproduced seed sources from the Northern region. The stocking density in the Southern region is generally lower. On the contrary, in the Northern region, clams are mostly sourced from artificial reproduction, and only a few farms use natural clam seed of various sizes from provinces like Ben Tre and Tien Giang. The farming methods involve extensive farming, collecting natural seed, and low-density stocking, ranging from 5 to 94 clams/m², with an average of 25/m². However, in several provinces, some farms practice high-density stocking, with an average ranging from 493 to 600 piece/m², and in some cases, even up to 1,100 clams per square meter (with clam sizes around 2,000 clams/kg). Farming at high densities extends the farming period to about 24 to 28 months [1] to get sizes of 70 to 100 piece/kg. In the Northern provinces such as Thai Binh, Nam Dinh, Thanh Hoa, Ninh Binh, and Ha Tinh, the clam farming density is relatively high,

ranging from 2,500 to 4,200 piece/m² (with clam sizes of 300-400 piece/kg), exceeding the recommended guidelines by 5 - 17 times [7].

The clam farming productivity varies between different ecological regions and localities. Thai Binh, for instance, reaches 25 tons/ha, and some exceptional areas achieve up to 50 tons/ha/crop. Nam Dinh records a productivity of 10-15 tons/ha/crop, with many models surpassing 20 tons/ha/crop, and certain production areas even exceed 40 tons/ha/crop. The Mekong Delta region attains an average productivity of 7.09 tons/ha/crop, with Tien Giang standing out at 11.33 tons/ha/crop [7]. Ben Tre has a slightly lower productivity of 7.5 tons/ha/crop, with 15-20% of the clams is left to maintain the spawning stock for subsequent years [6]. Tra Vinh and Kien Giang achieve productivities of 5 and 7 tons/ha, respectively. In regions with high production volumes (e.g., Thai Binh, Nam Dinh, Ninh Binh, Thanh Hoa), mechanical means are often employed for pond improvement and clam harvesting. In contrast, areas with conservation regulations, such as Ben Tre and Tien Giang, or regions with lower productivity, tend to opt for manual harvesting and extensive farming practices [6, 7]. It's important to acknowledge that the timeframe for selective harvest cycles in the South might be comparatively shorter than the simultaneous harvest approach employed in the North.

3.3. Cooperation among stakeholders in sustainable development

Currently, Ben Tre has seven clam cooperatives certified with MSC certificates, and information about 5 of them is presented with three other area of ASC certificate in Nam Dinh, Ninh Binh and Tra Vinh (Table 2). Currently, clam cooperatives mainly operate based on the 2012 Law on Cooperatives and are influenced by the unique historical formation and development as well as the specific conditions of each locality. The type and nature of user group participation in decision-making vary lightly based on the specific conditions of different cooperatives on the three coastal districts of Ben Tre, two districts of Tra

Vinh, Nghia Hung district in Nam Dinh and Kim Son district in Ninh Binh.

Ben Tre province in Mekong River Delta has successfully implemented a co-management system for clam farming since 1997 (Table 2),

which brings together the government, the local community, and other relevant stakeholders. The provincial People's Committee plays a vital role by granting land use rights to cooperatives for clam cultivation, exploitation, and protection.

Table 2. Information about some cooperatives and linked clam (*M. lyrata*) farming areas that have achieved MSC or ASC certifications

Name	Year of Establishment	No. of households	Farming area (ha)	Certificate
Rang Dong (Binh Dai, Ben Tre)	1997	3,700	1,500	MSC
Dong Tam (Binh Dai, Ben Tre)	2002	2,600	242	MSC
An Thuy (Ba Tri, Ben Tre)	2004	4,500	352	MSC
Tan Thuy (Ba Tri, Ben Tre)	2004	2,964	325	MSC
Thanh Loi (Thanh Phu, Ben Tre)	2004	650	404	MSC
Lenger Farm linked Clam farming area (Nghia Hung, Nam Dinh)	2020	n/a	500	ASC
Kim Son Clam Cooperative (Kim Son, Ninh Binh)	2022	110*	500	ASC
Clam farming area (Cau Ngang and Chau Thanh, Tra Vinh)	2023	n/a	433	ASC

*Note: * There are 95 households from Ninh Binh, 10 from Nam Dinh and 5 from Thanh Hoa; 10 are farmers cum traders.*

Source: Mai Van Tai and Pham Anh Tuan (2023)[6].

The coastal regions of Ben Tre were categorized into specific zones to serve diverse objectives encompassing conservation, cultivation, policy formulation, and regulatory measures associated with clam harvesting and farming. These zones also offer guidance for co-management entities and facilitate coordination across multiple endeavors, including the integration of scientific and technological advancements, partnerships with research institutions and NGOs, collaboration with coastal border guards and law enforcement, as well as conflict resolution and industry-related problem-solving [6, 9].

The local community, represented by cooperatives, plays an active role in decision-making regarding operational mechanisms, planning, and implementation of production and

business activities. They follow laws and regulations specified in cooperative internal rules and have the autonomy to elect their representatives and participate in cooperative management. To support their initial operations and enhance the awareness and management capacity of cooperative members and staff, the cooperatives receive financial and technical assistance from local authorities.

NGOs like WWF, FACOD, ICAFISH, etc, along with research institutions, provide valuable expertise and support to the clam farming sector [1, 5, 6, 9]. The mandate of the National Department of Quality, Processing, and Market Development (NAFIQPM) encompasses overseeing food safety surveillance in designated regions [13], along with environmental and disease monitoring for aquaculture initiatives as

endorsed by Research Institute for Aquaculture No. 1, No. 2, No. 3 (RIA1, RIA2, RIA3).

Development of value chains

Support from both businesses and NGOs has significantly benefited clam farming areas, as exemplified by WWF and the Sustainable Fisheries Fund's assistance in the MSC certification process in Ben Tre, covering certification costs. Similarly, Lenger Vietnam and HASUVIMEX's support for ASC certification in Nam Dinh and Ninh Binh serves as valuable models for other regions to develop their standards. However, challenges persist for small-scale fisheries in achieving financial sustainability. In Ben Tre, clam farmers have gained access to domestic and international markets through Hung Truong Phat Company and Ben Tre Seafood Joint Stock Company, yet cooperation between cooperatives and processing companies remains limited, with delayed payments compared to traders. Export-oriented processors mainly purchase clams sized between 80 to 120 clams per kilogram, while larger clams (40-60 clams per kilogram) are primarily intended for the domestic market. Traders play a vital role in purchasing and marketing clams, meeting the requirements of processing companies for both export and domestic consumption. The MSC certification in Ben Tre and ASC in Nam Dinh, Ninh Binh and Tra Vinh have been pivotal in enabling clam farming to explore new markets in Europe, the United States, Japan, etc fostering a clam market with enhanced profitability. This certification proves to be a valuable support system, promoting sustainable practices and facilitating improved market access for clam farmers in the Vietnam.

There is a wide variety of processed products made from clams, including frozen IQF boiled clam meat, boiled whole clam in shell, fresh whole clams, and canned clam meat, among others. Overall, clam products are quite popular and well-consumed in both the domestic and export markets, with many items being available in major supermarkets within the country. The top 10 regions contributing to this industry are Thanh Hoa, Ben Tre, Nam Dinh, Binh Thuan, Thai Binh,

Hai Phong, Soc Trang, Kien Giang, Quang Ninh, and Tien Giang, accounting for 97% of the total revenue. Among them, Thanh Hoa holds the largest share at 30%, followed by Ben Tre at 20%, and Nam Dinh at 10%. The three largest companies involved in this sector are Thanh Hoa Seafood Import-Export Joint Stock Company, Ben Tre Seafood Joint Stock Company, and Lenger Vietnam Seafood Company.

3.4. Main constraints and challenges in clam farming development

3.4.1. Insufficient clam seedling supply

The existing insufficiency in both quantity and quality of clam seedlings fails to effectively fulfill the substantial market demand. Present provisioning merely addresses an approximate range of 30 - 40% of the requisition, consequently engendering scarcities and a state of volatility within the industry. The dependence on naturally occurring sources for the acquisition of clam seedlings is environmentally unsustainable owing to their constrained availability and the attendant hazards of resource exhaustion.

3.4.2. Unclear land use and competition with other industries

The absence of comprehensive planning and the occurrence of impromptu expansion within coastal regions have contributed to the precarious and non-viable progression of bivalve aquaculture. The encroachment upon coastal zones and the ensuing expansion of aquaculture endeavors have engendered a contest for limited coastal spatial resources, thereby engendering detrimental repercussions upon local transportation networks and the tourism sector. Furthermore, the ramifications of climate change exert deleterious effects upon the productivity, quality, safety, and economic efficacy of clam farming, culminating in substantial deleterious financial outcomes.

3.4.3. Limited access to scientific and technological advancements, infrastructure, and capital

The predominant approach to clam aquaculture predominantly centers around small-scale familial operations, characterized by a dearth

of significant technological innovations and suboptimal infrastructural support. The industry's progress towards sustainability is hampered by the paucity of financial resources allocated for holistic strategizing and development. Additionally, the constrained access to refined methodologies in clam cultivation and the restricted avenues for acquiring knowledge and emulating prosperous paradigms further contribute to the challenges faced by the sector.

3.4.4. Market challenges

Fluctuations in both clam product consumption trends and pricing dynamics have engendered a state of instability that exerts notable impacts upon both the domestic and export - oriented markets. The presence of suboptimal hygiene and food safety protocols has yielded impediments in the realm of compliance with stipulated exportation prerequisites. Additionally, a deficiency in the commitment towards upholding desirable attributes such as product quality, dimensions, and the crucial meat-to-shell ratio has conspicuously contributed to a compromised reception within the market sphere. The clam aquaculture context within Vietnam is categorized as belonging to classification B, a classification that constrains the direct exportation of live clams, thereby mandating the precondition of processing anterior to their international consignment. This multifaceted scenario thus presents a formidable quandary in the concerted endeavor to amplify the export valuation of said clam products..

3.4.5. Climate change, environmental management, disease, and food safety

Coastal clam aquaculture is encountering heightened susceptibility to the ramifications of climate change, precipitating irregular productivity patterns and financial setbacks. Escalating turbidity of sediments in clam farming regions, coupled with scarcities in freshwater attributed to prolonged drought conditions and the diversion of water via reservoirs serving hydroelectric and irrigation purposes, has induced elevated salinity levels. This elevated salinity significantly

compromises the growth trajectory and viability of clam populations. Concurrently, scholarly efforts and vigilant oversight pertaining to ecological governance and pathogenic countermeasures have lagged behind the imperatives of production demands. The absence of adequate disease mitigation protocols exacerbates episodic mass mortalities among clams, engendering economic adversity and environmental contamination. In order to surmount these multifaceted challenges and instate a trajectory of sustainable expansion within clam aquaculture, a comprehensive approach is imperative. This approach should encompass rectification of clam seedling supply inadequacies, refinement of spatial land management protocols, allocation of resources towards scientific and technological innovations, reinforcement of marketing strategies, and steadfast dedication to enhancing climate resilience and safeguarding ecological integrity.

4. CONCLUSION AND POLICY RECOMMENDATION

The clam farming industry in Vietnam has risen to prominence as a noteworthy marine aquaculture sector, holding substantial economic value and promising developmental prospects. With its expansive coastline, extensive tidal flats, and diverse range of clam species, Vietnam possesses the ideal conditions for successful clam farming, particularly centered around *Meretrix lyrata*, commonly known as the Ben Tre clam, and *M. meretrix*.

The evolution of clam farming in Vietnam has witnessed remarkable advancements in seed production techniques, commercial farming methodologies, and seamless integration with processing and product marketing strategies. Concentrated farming zones have been established in numerous coastal provinces, yielding significant outputs. This sector significantly contributes to the country's marine aquaculture domain and amplifies its export worth.

Prominent strategic directives, exemplified by Decision 339/QĐ-TTg [2] and Decision 1664/QĐ-TTg [3], underscore the pivotal role of clam farming while delineating development strategies

up to 2030 and envisioning targets until 2045. These directives underscore focused expansion within designated regions, investments in seed production technologies, and the augmentation of export-oriented processing to ensure the enduring growth of the clam farming sector.

However, despite the evident growth potential, clam farming confronts several challenges. Ensuring the quality of raw materials, processing, and end products, alongside effective environmental management, food safety measures, genetic preservation, and land utilization strategies, are pivotal concerns that warrant immediate attention to guarantee the sector's sustainable progression.

To actualize sustainable development within the clam farming domain, it is imperative to conduct comprehensive research and evaluations that assess the harmonious coexistence and success of varied production models across diverse regions. Collaborative efforts and the exchange of experiences, technologies, and resources among stakeholders will expedite the adoption of best practices and foster sustainable expansion within the industry.

A primary challenge lies in the inadequate availability of clam seedlings to meet the escalating demand. Dependency on natural sources for clam seeds is untenable and leads to shortages, particularly in specific provinces. Cultivating clam seedlings assumes paramount importance in alleviating this concern and securing a consistent supply of top-tier seedlings to support sustainable clam farming nationwide.

Prudent land use planning and management are indispensable to mitigate clashes with other sectors and ensure the constancy of clam farming. The ramifications of climate change and adept environmental stewardship hold pivotal significance in safeguarding the industry's resilience and productivity. The focal points should encompass disease prevention, meticulous environmental surveillance, and the enhancement of hygiene and food safety protocols to align with

both domestic demands and international market prerequisites.

Investments in scientific breakthroughs and technological innovations, coupled with substantial infrastructural enhancements, stand as pivotal determinants in enhancing the productivity and efficiency of clam farming. Furthermore, the augmentation of market strategies is imperative to stabilize consumption patterns and pricing for clam products, catering to both local and global markets.

In summation, the clam farming industry in Vietnam harbors substantial potential for sustainable growth, contingent upon effectively addressing the prevailing challenges. By prioritizing the enhancement of clam seedling supply, the implementation of judicious land use strategies, investments in scientific and technological progress, bolstering market approaches, and fortifying climate resilience and environmental preservation endeavors, Vietnam can chart a course toward a thriving and enduring future for the clam farming sector.

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