

Aquaculture Marketing and Supply Chain Management

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Abstract

The aquaculture market and its supply chain are vital in delivering high-quality seafood to meet growing global demand. From fish farms to the dinner table, this system includes many steps to ensure fresh, safe and accessible products for consumers. The supply chain is complex, handling fresh, frozen and processed products like tilapia, shrimp and seaweed. Marketing in aquaculture goes beyond simple buying and selling; it involves grading, storing and transporting fish to maintain quality and meet diverse consumer tastes. Producers use a variety of approaches, from cooperatives to high-tech systems, to streamline the supply chain and reach both local and global markets effectively. In recent years, technological advancements like Recirculating Aquaculture Systems (RAS) and Biofloc technology have helped boost production and efficiency. The Indian government has also taken steps to support this sector with projects like Fishwale, India's first e-fish market app and the development of modern fish markets and smart fishing harbors. These initiatives aim to strengthen infrastructure, improve storage and distribution and increase market access, benefiting both producers and consumers. Altogether, an efficient, well-managed supply chain is essential for supporting the aquaculture market's growth, making seafood more accessible, affordable and sustainable for a diverse population.

Keywords Aquaculture market, Marketing function, Marketing efficiency, Price spread, Supply chain

1. Introduction

Aquaculture refers to the practice of cultivating aquatic organisms such as fish, shellfish and aquatic plants for human consumption. The aquaculture market encompasses the cultivation and harvesting of aquatic organisms, including fish, shellfish, algae and other marine species, in controlled environments. As demand for seafood rises and wild fish

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stocks decline, aquaculture has emerged as a vital sector in global food production, supporting sustainable seafood supplies and creating economic opportunities, especially in coastal and rural areas. The marketing process of aquacultural activities includes, freshwater Aquaculture market, which involves fishes mainly IMC and exotic carps raised in lakes, rivers and ponds. Marine Aquaculture is focused on farming in saltwater environments like oceans and seas and Mariculture extends this practice to the open ocean or sections enclosed for farming purposes. Each culture system processes through different marketing channels.

In aquaculture industry the market's expansion has been driven by technological advances in breeding and farming techniques, growing consumer demand for sustainable seafood options and increased regulation favoring environmental responsibility. Together, these elements make aquaculture essential for ensuring food security and supporting sustainable fish food production worldwide.

Marketing and supply chain management is crucial to the success and sustainability of the aquaculture industry. Both play vital roles in ensuring the efficient delivery of products from farms to consumers, maximizing profits for producers and meeting consumer demands effectively.

2. Scope of the Aquaculture Market

- *Global Expansion:* Aquaculture has been growing rapidly in Asia, with China, India, Indonesia and Vietnam as leading producers, contributing to over 80% of global aquaculture production (FAO, 2022). The market is also expanding in regions such as North America, Europe and parts of Africa as technological advancements make aquaculture more accessible and profitable worldwide.
- *Diverse Products:* The market includes species like salmon, shrimp, tilapia, catfish and oysters, along with emerging markets for algae and seaweed, which are used in both food and non-food products like biofuels and cosmetics.
- *Economic Contribution:* Aquaculture plays a critical role in rural development, job creation and food security. In fact, the sector provides livelihood to about 25 million fishers and fish farmers at the primary level and twice the number along the value chain (NFD, 2024). It is a primary source of income and nutrition for millions worldwide, particularly in coastal communities.
- *Sustainability Focus:* As wild fish stocks decline and environmental concerns rise, rising fishing cost, sustainable aquaculture practices have gained importance.

The aquaculture market has several distinct characteristics:

- *High Perishability:* Fish and aquaculture products are highly perishable, requiring immediate processing, refrigeration, or sale to prevent spoilage. This creates a strong emphasis on logistics and timing.
- *Irregular Supply:* The supply of fish varies based on natural factors like

seasonality, weather and breeding cycles. This irregular supply can create fluctuations in price and availability.

- *Scattered Production:* Fish production is dispersed across various regions, which leads to logistical challenges in transporting fresh products to markets and consumers in distant locations.
- *Regional Demand Variances:* Demand for fish types and forms vary by region. For example, northeastern consumers in India may prefer dried fish, while other states might consume fresh or frozen fish more.
- *Inadequate Processing Facilities:* There is often a lack of cold storage, ice boxes and processing facilities, especially among smaller retailers. This impacts the ability to store fish for extended periods, leading to potential wastage.
- *Specialized Market:* The aquaculture market, commonly known as the fish market, is highly specialized, selling only fish and aquaculture products, with little to no other commodities.
- *Short Period Market:* These markets operate briefly each day, during which the supply is fixed and inelastic. Once the fish is sold, no further supply can be introduced until the next market session, limiting daily sales to the initial stock.
- *Regulation and Compliance:* Aquaculture is regulated to ensure food safety, environmental protection and fair labor practices. Regulations vary widely across countries, affecting production standards, use of antibiotics, feed practices and export policies.
- *Market Volatility:* The market can be sensitive to environmental factors, disease outbreaks and fluctuating feed costs. Disease management and biosecurity are critical, as diseases can severely impact yields and product quality, impacting prices and production levels
- *Integration with Supply Chain and Logistics:* Efficient supply chain management is crucial in aquaculture, especially since seafood is perishable and requires timely processing, distribution and cold chain management to ensure freshness and safety.

Table 1: Difference between the agriculture market and aquaculture market systems

Agriculture Market	Aquaculture Market
<i>Environment:</i> Primarily soil-based, focusing on land management, crop rotation and soil health.	<i>Environment:</i> Aquatic-based (freshwater and brackish water); relies on water quality management in ponds, rivers and coastal areas.
<i>Species and Life Cycles:</i> Involves staple crops like rice, wheat and pulses, as well as livestock. Crop cycles are heavily dependent on the monsoon season.	<i>Species and Life Cycles:</i> Focuses on species like shrimp, rohu and catla; aquaculture often relies on monsoon water sources and controlled ponds.

Agriculture Market

Technology and Automation: Limited adoption of high-tech tools; traditional methods are still widely used, though precision farming is growing.

Sustainability and Environmental Impact: Issues with soil erosion, groundwater depletion and excessive pesticide use; government promotes organic and sustainable farming practices.

Market and Consumer Perception: Established market with demand for staples; rising interest in organic products among urban consumers.

Climate Change Impact: Sensitive to droughts, unpredictable weather and temperature changes that affect crop yields, especially with monsoon dependence.

Disease and Health Management: Crop diseases and pests like rust, blight and locust attacks can significantly impact yields; management through pesticides and organic methods.

Globalization and Trade: India is a major exporter of rice, spices and other agricultural products, but the sector is also protected by certain trade policies.

Government Support: Initiatives like the Pradhan Mantri Krishi Sinchai Yojana (PMKSY) and Soil Health Card Scheme support agriculture, improve water use and enhance productivity.

Aquaculture Market

Technology and Automation: Increasing use of technology, like automated feeding systems, in commercial shrimp farming; however, small-scale farmers often use traditional practices.

Sustainability and Environmental Impact: Growing focus on sustainable aquaculture to avoid water pollution and over use of antibiotics; certifications like BAP (Best Aquaculture Practices) are becoming more common.

Market and Consumer Perception: High demand for farmed shrimp and fish, particularly for export; growing domestic demand for seafood due to changing dietary preferences.

Climate Change Impact: Vulnerable to changes in water temperature, salinity and coastal flooding; climate change affects shrimp and fish health, especially in coastal farming.

Disease and Health Management: Disease outbreaks like White Spot Syndrome in shrimp are common; farmers often rely on antibiotics and water quality controls.

Globalization and Trade: India is a top exporter of shrimp globally, with markets in the U.S., Japan and Europe; exports are sensitive to international quality standards and tariffs.

Government Support: Programs like the Pradhan Mantri Matsya Sampada Yojana (PMMSY) provide funding, infrastructure and technology support for sustainable aquaculture and export growth.

3. Classification of Aquaculture Market

The aquaculture market can be classified based on various factors, including Market Structure, period, geographic location and structure (Chandra, 2013). Here's an overview of the main classifications:

3.1. Market Structure

- *Wholesale Markets:* Large-scale markets where fish are sold in bulk to distributors, restaurants and retailers.
- *Retail Markets:* Direct-to-consumer sales, often at local fish markets or specialized stores.
- *Export Markets:* Markets that deal with the international trade of aquaculture products, typically involving species like shrimp, salmon and certain shellfish.
- *Online Markets:* A growing segment where fish and aquaculture products are sold through e-commerce platforms, providing convenience for consumers.
- *Vendor:* Fish vendors operate with mobility and crucial for distribution and retail in aquaculture market, often using small vehicles or even bicycles to reach customers across various neighborhoods. This flexibility allows them to adapt to different demand levels and customer locations.

3.2. Geographical Location

- *Local Markets:* Serve nearby communities and regions, supplying fresh fish from local aquaculture farms.
- *National Markets:* Operate within the country, transporting aquaculture products across regions to meet demand in urban and rural areas. *E.g.*, Andhra Pradesh, often referred to as the “Aqua Hub” of India, is a major contributor to the country’s fish production. Andhra Fish Market, which operates on a national level, distributes a wide variety of fish and aquaculture products throughout India. Fish from Andhra Pradesh, such as rohu, catla, shrimp and tilapia, are transported across the country to urban markets in places like Delhi, Mumbai and Bengaluru, as well as to smaller towns and rural areas.
- *International Markets:* Involves the global trade of aquaculture products, influenced by demand in different countries and the ability to meet strict export standards. Shrimp is one of the most prominent examples of an international aquaculture market, with countries like India, Thailand, Vietnam and Ecuador being major exporters. These countries produce large volumes of shrimp through aquaculture, primarily for export to high-demand regions like the United States, Europe, Japan and China.

3.3. Sale Period

- *Permanent Markets:* These markets are open year-round and have a continuous supply, often found in urban areas with high demand.
- *Seasonal Markets:* Operate during certain seasons when specific fish are in high demand or more readily available.

- *Daily/Periodic Markets*: Open at fixed times daily, with a set period for fish sales. Often found in rural or small communities where supply is limited.

4. Overview of Aquaculture Market Functions, Product Mix, Integration and Efficiency

The aquaculture market system involves a range of interconnected processes to bring aquatic products from farms to consumers. This system includes not only the cultivation and harvesting of seafood but also marketing, distribution and management strategies that ensure the products reach their target markets efficiently and profitably.

4.1. Marketing Functions in Aquaculture

Marketing functions in aquaculture focus on moving products from production to the final consumer while maintaining quality and meeting demand (Kumar, 2014). Key functions include:

- *Buying and Selling*: Farmers sell their produce to wholesalers or directly to retailers and vendors, who then distribute it to markets or directly to consumers. This function facilitates the movement of fish from producers to buyers at different levels.
- *Grading and Standardization*: Fish and seafood are graded based on size, quality and type, which helps maintain product standards. Standardized grading allows for consistent pricing and quality expectations, essential in wholesale and export markets.
- *Storage*: Since fish is perishable, storage (including cold storage) is vital to prevent spoilage. Efficient storage facilities help extend the product's shelf life, stabilize supply and reduce wastage.
- *Transportation*: Transportation plays a key role in delivering fresh products from farms to local markets, vendors and international markets. Reliable logistics help maintain product quality, especially in refrigerated trucks or containers for long-distance transport.
- *Pricing*: Pricing in aquaculture is influenced by supply-demand dynamics, competition and costs associated with grading, storage and transportation. Price strategies also consider regional market conditions and consumer preferences.
- *Promotion*: Promotion strategies help boost demand by educating consumers about the health benefits of seafood, quality certifications and sustainability practices. This includes branding, certification labels (*e.g.*, organic, 3R's) and advertising to increase awareness and trust in the product.

4.2. Product Mix in Aquaculture

The product mix in aquaculture includes a variety of species and product forms to cater to diverse consumer preferences and regional demands. Common species include finfish (like tilapia, catfish and salmon), shellfish (such as shrimp, crabs and oysters) and seaweed. Products are offered in various forms: fresh (whole or filleted), frozen (for longer shelf life and

wider distribution) and processed (dried, smoked, marinated, or canned) to meet regional storage needs. Value-added products like fish burgers and ready-to-cook seafood provide convenience, appealing to busy consumers. Additionally, products vary by size and quality, with larger sizes often favored in international markets while smaller, more affordable options are popular domestically.

4.3. Market Integration in Aquaculture

Market integration in aquaculture involves creating a seamless connection between different stages of the supply chain to improve efficiency, reduce costs and ensure a stable product supply (Reddy *et al.*, 2023). Types of market integration include:

- *Horizontal Integration*: This occurs when multiple producers or vendors come together at the same level of the supply chain. For instance, fish farmers might form cooperatives to pool resources, standardize practices and negotiate better prices with wholesalers or exporters.
- *Vertical Integration*: Vertical integration involves a single entity controlling multiple stages of the supply chain, from production to retail. For example, a large aquaculture company might own fish farms, processing facilities and distribution channels, enabling greater control over quality, pricing and supply.
- *Forward Integration*: Some aquaculture producers expand into processing and retail, moving further along the supply chain to reach end consumers. This integration allows them to capture more value by offering finished products directly to retailers or consumers.
- *Backward Integration*: Aquaculture companies might invest in inputs like feed production or hatcheries to ensure a steady supply of resources, reducing reliance on external suppliers and minimizing production costs.
- *Global Market Integration*: With the international demand for seafood products like shrimp and tilapia, aquaculture markets integrate globally through exports and imports. This enables producers to tap into foreign markets and adjust supply according to global demand.

4.4. Marketing Efficiency and Approaches in Aquaculture

- *Supply Chain Efficiency*: Marketing efficiency in aquaculture depends heavily on the supply chain's ability to move products quickly and at low cost while maintaining quality. Innovations like cold chain logistics, automation and real-time tracking improve speed and minimize spoilage, ensuring that products reach consumers in peak condition.
- *Direct-to-Consumer Models*: Digital marketing and e-commerce enable aquaculture businesses to bypass traditional intermediaries, selling directly to consumers. This approach often reduces costs and allows for direct feedback, increasing customer satisfaction and fostering loyalty.
- *Market Access and International Expansion*: Expanding market access through international trade agreements, certification programs and

partnerships with global distributors helps aquaculture producers tap into new regions and meet global demand more efficiently.

4.5. Marketing Risk Management Strategies in Aquaculture

- *Environmental and Disease Risks:* The aquaculture industry faces risks from environmental factors (e.g., water quality, climate changes) and disease outbreaks, which can reduce production and impact profits. Risk management strategies include biosecurity protocols, regular health monitoring and vaccination programs to minimize losses.
- *Market Volatility and Price Fluctuations:* Aquaculture prices can be volatile, influenced by feed costs, changes in consumer demand and regulatory changes. To manage this risk, companies often use hedging strategies, maintain diversified product lines and establish long-term supply contracts to stabilize prices and reduce vulnerability.
- *Regulatory Compliance and Certification Costs:* Compliance with environmental, health and safety regulations can be costly, particularly when meeting international standards. Strategies to manage these risks include obtaining certification from reputable bodies like the Aquaculture Stewardship Council (ASC) or Global G.A.P., which not only helps meet regulatory requirements but also appeals to consumers focused on sustainability.
- *Logistics and Supply Chain Risks:* With perishable products, delays in the supply chain can lead to significant losses. To mitigate these risks, companies invest in cold chain technology, establish reliable transport partnerships and build redundancies into their distribution network, such as multiple storage facilities or backup transportation options.
- *Consumer Perception and Reputation Management:* Aquaculture occasionally faces consumer concerns over environmental impact, antibiotics use and fish welfare. Risk management strategies here involve transparency initiatives, such as detailed labeling and certifications, along with communication efforts to educate consumers on sustainable practices and the quality of farmed products.

5. Supply Chain Management in Aquaculture

Supply chain management in aquaculture is critical for ensuring that products are delivered fresh, safe and at a reasonable cost, all while maintaining a smooth flow from farm to consumer. Due to the perishable nature of seafood, aquaculture businesses must be especially vigilant in managing logistics, quality, costs and relationships across the supply chain to maximize profitability and meet regulatory standards. Marketing costs and margins in the aquaculture market can vary significantly based on factors like species, region and market channels. Here are some general aspects to consider:

5.1. Marketing Costs

Marketing costs in aquaculture typically include expenses associated with:

- *Processing*: Costs of cleaning, gutting, filleting, freezing, or packaging fish, which add value but can be costly depending on the processing level.
- *Transportation*: Moving fish from farms to processors, distributors and ultimately retail or export markets. Transportation costs can be high, especially for live or fresh fish, which require special handling and refrigerated transport.
- *Storage*: Maintaining freshness often involves cold storage, which is necessary but costly.
- *Distribution*: Costs for local or global distribution networks, including handling and middlemen.
- *Packaging*: Packaging varies widely, from simple ice and box setups to vacuum-sealed, labeled and branded packages for direct sale, which can affect costs.
- *Marketing and Advertising*: Many aquaculture businesses invest in branding, certification (such as organic or sustainability certifications) and other promotional efforts, which also add to the total cost.

5.2. Profit Margins and Price Spread in Aquaculture

Profit margins in aquaculture can vary by product type, level of processing and market demand:

- *Direct-to-Consumer Sales*: Selling directly at local markets or via online platforms can yield higher margins by cutting out middlemen, though this requires additional marketing efforts.
- *Wholesale*: Selling to distributors, supermarkets, or restaurants usually results in lower margins but involves fewer marketing costs, as bulk sales offset some of the expenses.
- *Product Type*: High-demand species (such as salmon, shrimp, or tilapia) often yield higher margins than lower-demand species.
- *Market Differentiation*: Niche markets, like organic or sustainably farmed fish, often command higher prices and, consequently, higher margins, though the certification and marketing can increase costs.
- *Geographic Location*: Margins also depend on production costs in specific regions. Some regions have lower production and marketing costs due to infrastructure, lower labor costs, or proximity to markets.

Price Spread in Aquaculture Market refers to the difference in prices at various stages of the supply chain, from production to the final sale to consumers. It typically reflects the costs added at each level, such as transportation, handling, processing and retail margins. The price spread can vary significantly depending on factors like the type of product, location, seasonality and the level of value-added processing. For the supply chain can be represents as figure 1.

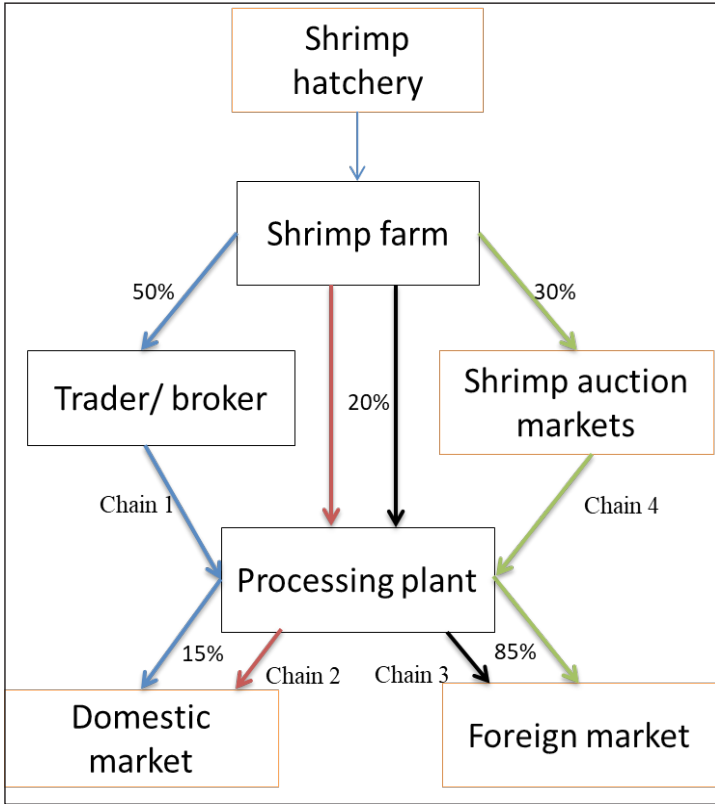


Figure 1: Supply chain for shrimp market

a) *Farm Gate Price:* The price at which aquaculture farmers sell shrimp to wholesalers or processors. This price is typically the lowest in the supply chain, reflecting the raw cost of production (e.g., feed, labor, water management).

b) *Wholesale Price:* The price at which wholesalers purchase shrimp in bulk from farms or processors and sell it to retailers. The price here includes costs like transportation, storage and packaging. The price spread from farm gate to wholesale can be significant due to these added costs.

c) *Retail Price:* The final price at which shrimp is sold to consumers in supermarkets or fish markets. The retail price typically includes a markup for the retailer’s profit, additional packaging costs and any extra processing, such as freezing or value-added products like ready-to-cook shrimp.

Price Spread Breakdown:

- From Farm to Wholesale: ₹ 450.00 - ₹ 300.00 = ₹ 150.00
- From Wholesale to Retail: ₹ 750.00 - ₹ 450.00 = ₹ 300.00
- Total Price Spread (Farm to Retail): ₹ 750.00 - ₹ 300.00 = ₹450.00

Table 2: Price spread for shrimp

Stage	Price kg ⁻¹ (INR)	Description
Farm Gate Price	₹ 300.00	Price at which the shrimp is sold by the farmer to wholesalers or processors.
Wholesale Price	₹ 450.00	Price at which shrimp is sold by wholesalers to retailers. Includes transport and handling costs.
Retail Price	₹ 750.00	Final price at which shrimp is sold to consumers in stores or fish markets. Includes retail markup and additional processing.

5.3. Challenges Affecting Costs and Margins

- *Perishability:* Fresh fish has a limited shelf life, so timing and fast transport are essential, impacting costs.
- *Price Fluctuations:* Market prices for fish can vary, influenced by factors like seasonality, weather and competition, affecting both margins and costs.
- *Compliance and Certification:* Regulatory compliance and certifications (such as FDA, EU regulations) can be costly but may allow access to higher-margin export markets.

Overall, efficient supply chain management in aquaculture requires attention to costs, rigorous quality control, strong relationships and optimized logistics. By focusing on these elements, aquaculture companies can minimize waste, control expenses and deliver high-quality products that meet the expectations of today's quality- and sustainability-focused consumers.

6. Recent Advances and Role of Govt. for Developing Aquaculture Market

Recent advances in the aquaculture market have seen significant technological and infrastructural developments. Focused efforts on Recirculating Aquaculture Systems (RAS), Integrated Multi-Trophic Aquaculture (IMTA) and Biofloc systems are boosting fish production by improving resource efficiency and reducing environmental impact. India's first e-fish market app, FishWale, launched in Assam, aims to digitally connect fish producers and consumers, enhancing transparency and market access. Additionally, lab-grown fish meat research by CMFRI (Central Marine Fisheries Research Institute) opens new possibilities for sustainable protein sources. In terms of infrastructure, world-class fish markets are being developed in Arunachal Pradesh and Assam, while smart and integrated fishing harbors in Gujarat, Puducherry and Daman & Diu are being prioritized under the PMMSY (Pradhan Mantri Matsya Sampada Yojana) to promote sustainable fisheries growth and improve market access.

7. Conclusion

Marketing and supply chain management are integral to the success of

aquaculture businesses. Targeted marketing strategies such as segmenting consumer groups, utilizing social media and enhancing branding allow companies to connect with eco-conscious and health-oriented consumers, while transparent labeling and eco-friendly packaging build trust. On the supply chain side, cost management, quality assurance, reliable supplier relationships and advanced logistics systems are vital to delivering fresh, safe and sustainable products. Together, these components strengthen competitive positioning, improve profitability and enhance market reach.

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