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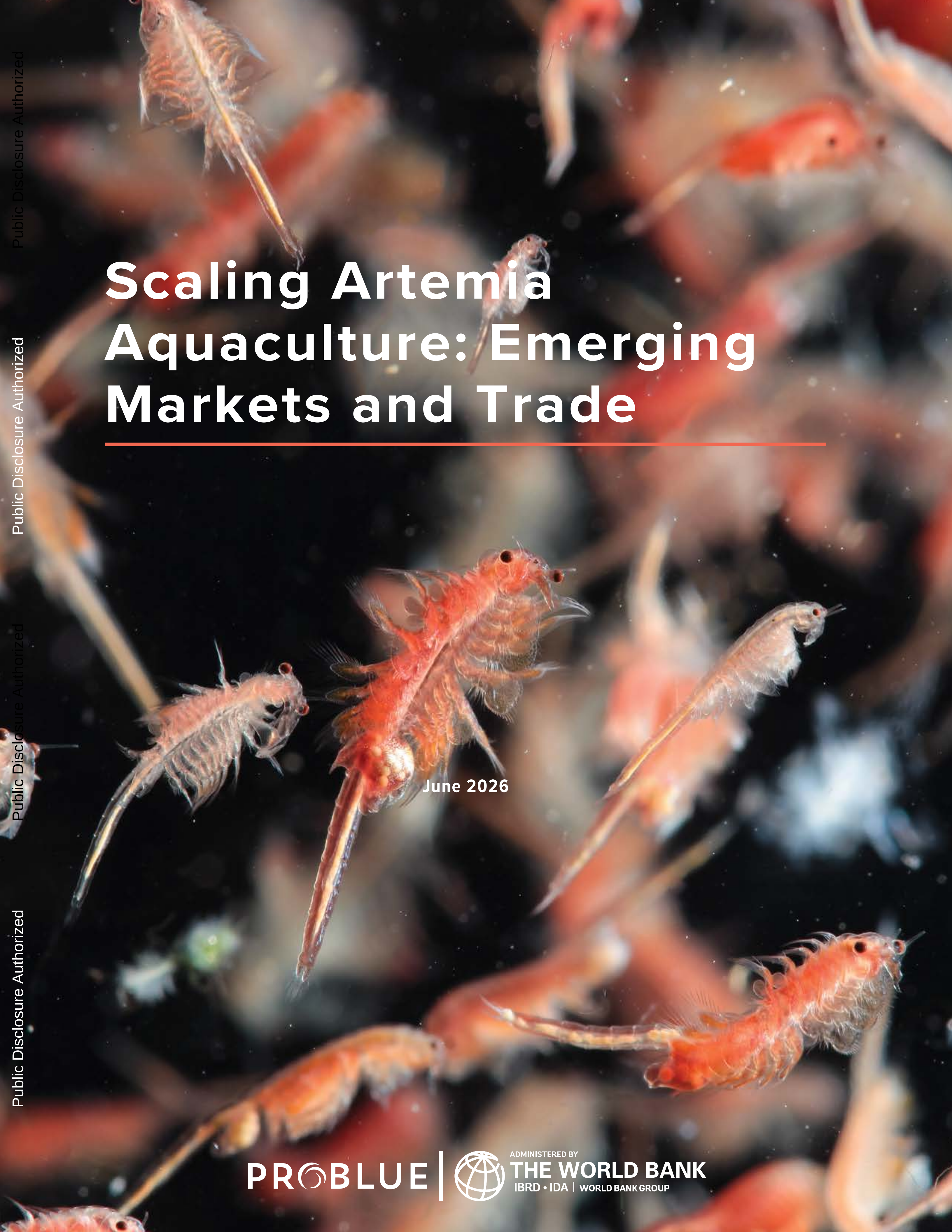

Scaling Artemia Aquaculture: Emerging Markets and Trade

June 2026

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GLOBAL ARTEMIA EMERGING MARKETS AND TRADE

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GLOSSARY

Artemia biomass: Live, mainly adult Artemia, which may be bulk harvested for use as animal feed or human food.

Cyst: A dormant Artemia embryo encased in a protective shell, capable of surviving harsh conditions for decades. Produced when habitats experience extreme conditions (salinity, temperature, or dissolved oxygen)

Cyst separation: The process of removing empty cyst shells from newly hatched Artemia nauplii, typically using methods like sieving or magnetic separation systems.

Decapsulation: Removal of the hard outer shell of Artemia cysts, typically using a chemical process. This allows cysts to be used as a direct feed without the need for hatching.

Ecotoxicology: Study of the effects of chemicals on biological organisms, particularly at the ecosystem level.

Gene (cyst) bank: A repository for storing genetically diverse Artemia cysts of different species and strains under controlled conditions to preserve genetic resources for future breeding, research, and aquaculture use.

Solar saltworks: Facilities where salt is produced through the evaporation of seawater or brine in shallow ponds using solar energy, often providing a habitat for Artemia populations.

Initial Commercial Development: Farming has begun, showing technical feasibility, but needs scaling and market development.

Technically Successful but No Commercial Follow-Up: Proven viability but lack of sustained investment, market, or scaling.

Potential for Artemia Farming: No commercial projects yet, but environmental conditions suggest strong potential if investment and research were applied.

PROBLUE: An umbrella multi-donor trust fund administered by the World Bank that supports sustainable and integrated development of marine and coastal resources in healthy oceans

ACRONYMS

ASA	Advisory Services and Analytics
BHB	Bohai Bay
CAGR	Compound Annual Growth Rate
EPA	Eicosapentaenoic Acid
FAO	Food and Agriculture Organization of the United Nations
GSL	Great Salt Lake
HUFA	Highly Unsaturated Fatty Acids
NGO	Nongovernmental Organization
PPP	Public Private Partnership
QA	Quality Assurance
R&D	Research and Development
RTE	Ready-to-Eat
TTL	Task Team Leader

EXECUTIVE SUMMARY

This **Global Artemia Emerging Markets and Trade report** offers a comprehensive overview of Artemia products and markets, from global trends to country-level case studies. It provides an in-depth assessment of traditional and emerging uses, supply systems, investment opportunities, and strategic risks. The study is global in nature, with illustrative cases of ‘farmed’ Artemia in Bangladesh, China, Thailand, and Viet Nam in Asia and Kenya in Africa and how new farmed products can compete with wild Artemia products.

The *report* provides the quantitative foundation for the synthesis, linking the production and governance analyses with global trade, price, and investment trends. Together, six studies form a coherent analytical suite:

- **Global Overview of Production and Conservation** - identifies the ecological and biological basis for sustainable Artemia supply.
- **Governance Frameworks and Regulatory Gaps Assessment** - maps national and international policy conditions influencing industry formalization.
- **Country Value Chain Studies** - provides cost structures and production models from five pilot countries (Bangladesh, China, Thailand, Viet Nam, and Kenya), illustrating diverse pathways from artisanal to industrial Artemia farming.
- **Human Food Systems Study** - explores Artemia’s potential as a novel, climate-resilient protein source for food and nutrition security.
- **Global Technology and Innovation Inventory** - catalogs emerging production technologies, processing tools, and digital innovations.

By connecting these strands, the *report* situates Artemia within a USD 50 billion aquaculture value chain, identifies regional demand drivers (shrimp, finfish, crab, pet food, and nutraceuticals), and highlights investment priorities in production diversification, biomass processing, and quality certification. It directly underpins the synthesis sections on competitiveness, business models, and investment pathways, providing the market logic behind the policy, governance, and social findings of the other reports.

Market Context

Artemia remains the cornerstone of modern aquaculture. Its cysts are indispensable for shrimp, marine fish, and crab hatcheries, which collectively underpin an aquaculture industry exceeding **USD 50 billion** in annual output. Despite this centrality, the global Artemia market continues to rely overwhelmingly on **wild harvests—over 90 percent of supply**—from a handful of hypersaline lakes, chiefly the **Great Salt Lake (GSL, United States)** and the **Caspian and Central Asian** systems.

Growing aquaculture demand, recurring droughts, and export restrictions in producing countries have pushed the industry toward diversification and farmed supply models in Asia and, more recently, Africa. Less than **10 percent** of Artemia today is farmed—yet farmed supply could reach **25–30 percent by 2035**, generating **USD 150–200 million** in new value.A **10 percent shift** from wild to farmed Artemia could unlock **USD 50–70 million** annually and create **15,000–20,000** coastal jobs.

Global Supply, Trade, and Market Value

- **Production volumes:** Global cyst output is estimated at 3,000–3,800 tonnes per year, with wild sources providing the majority. Farmed supply is led by China (≈350 tons) and Viet Nam (≈30 tons), followed by emerging small-scale production in Bangladesh and India.
- **Market value**: The overall Artemia economy—including cysts, biomass, and by-products—is worth roughly USD 350–400 million per year and projected to exceed USD 500 million by 2035, growing at an average 8–10 percent compound annual growth rate (CAGR).
- **Trade flows:** Major exporters include the United States, China, Kazakhstan, and Iran, supplying high-grade cysts to China, Thailand, India, Indonesia, and Viet Nam, which together account for over 70 percent of global imports.
- **Seasonality:** Prices peak between October and February, following harvests in the northern hemisphere, and soften midyear as inventories rise in Asia.
- **Price range:** Wholesale cyst prices have fluctuated from USD 25 per kilogram (low-grade) to USD 180 per kilogram (premium, decapsulated, or certified lots) over the past decade, influenced by climatic shocks, harvest yields, and speculative storage.

Each tonne of Artemia cysts supports the production of roughly **3,000–4,000 tonnes of shrimp**, linking the Artemia trade directly to global seafood markets valued in the tens of billions.

Each tonne of high-grade cysts supports approximately **USD 15,000–20,000** in shrimp exports, while biomass used as a **5–10 percent fish meal replacement** could yield a **USD 150 million feed-ingredient market by 2035**.

Product Segments and Applications

- Derived and value-added products—decapsulated cysts, hydrolysates, enriched powders, and ready-to-hatch pastes—are expanding at more than 10 percent per year, representing **USD 30–40 million** today and potentially **USD 100 million by 2030**.
- **Cysts (hatching eggs)** represent about **70 percent** of the total market value. Demand is dominated by shrimp hatcheries but is expanding into marine finfish culture (for example, groupers and pompano).
- **Biomass (live or dried Artemia)** accounts for **20–25 percent** of the total value, mainly used as live feed for ornamental fish, larvae of marine species, and an emerging additive in aquafeeds and poultry feeds.
- **Derived products:** Decapsulated cysts, nauplii pastes, and hydrolysates are gaining traction in premium feed and pet-food markets, while nutraceutical and human-food prototypes (protein powders and fortified snacks) are under development in Asia.
- **Regional differentiation**
  - **Asia** is both the largest consumer and processor, with China and Viet Nam importing, hatching, and re-exporting high-value nauplii.
  - **Europe** maintains niche, certified markets for ornamental species.
  - **Africa** is an emerging import region, especially Egypt, Kenya, and Nigeria, as aquaculture expands. Africa and South Asia are poised for import substitution and new production. Local cyst and biomass output could offset a **USD 80–100 million annual import bill** while building regional feed security. Converting just **20,000 ha of underutilized salt ponds** across Africa could yield **1,000 tons per year** of cysts, equivalent to **USD 50–80 million** in domestic value.

Price Dynamics and Value Chain Structure

- **Concentration:** A few multinational traders control up to **60 percent** of the cyst trade, creating information asymmetry and price opacity for downstream buyers.
- **Processing margins:** Cleaning, grading, and decapsulation add **30–50 percent** to raw cyst value.
- **Import substitution potential:** Africa and South Asia currently import Artemia worth USD 80–100 million annually—representing a key medium-term opportunity for regional production.
- **Quality differentiation:** Certified, high-hatch cysts command price premiums of **30–50 percent** in Asian markets, while ungraded or bulk cysts sell near commodity levels.

Market Risks and Emerging Trends

- **Supply vulnerability:** Climate-driven declines in wild harvests—for example, a 40 percent reduction in the GSL over the past decade—pose structural risks to global supply chains.
- **Biosecurity and traceability:** Buyers increasingly demand verified origin and contaminant-free cysts; absence of international certification limits transparency.
- **Technological innovation:** Decapsulation, enrichment, and automated hatching systems are raising conversion efficiency and expanding product differentiation.
- **Diversification:** Growth of biomass-to-feed and pet-food applications may absorb up to 15 percent of total Artemia use by 2035.
- **Regional expansion:** New saline-pond pilots in Kenya, Senegal, Iran, and India demonstrate geographic diversification and early policy interest.

Opportunities for Market Development

- **Farmed Artemia Expansion:** Support research, extension, and seed supply systems to scale farmed production in Asia and Africa and stabilize global supply. If just 10 percent of current wild harvests were replaced by farmed supply, global Artemia trade could unlock USD 50–70 million in new market value, while reducing supply volatility and creating 15,000–20,000 rural jobs in saline-land areas.
- **Value-chain transparency:** Facilitate certification, traceability, and trade data systems to improve pricing efficiency.
- **Processing and product upgrading:** Encourage private investment in cyst cleaning, decapsulation, and enrichment to capture higher margins.
- **Feed and human-food innovation:** Promote research and development (R&D) and public–private partnerships (PPPs) for Artemia-based feed ingredients and fortified foods.
- **Regional trade hubs:** Develop logistics, cold chain, and quality labs to position strategic countries (for example, Viet Nam, Kenya, and Iran) as regional distribution centers.

Challenges and Risks

- Climate change is threatening the sustainability of wild Artemia sources, with fluctuating salinity, drought, and pollution affecting natural lakes.
- Overreliance on wild cysts increases supply volatility and price uncertainty, highlighting the need for expanded farm-based production.
- Technological gaps persist in validating Artemia biomass for use in livestock and human diets.
- Informal Artemia markets lack quality assurance (QA), hampering scalability and investment.
- Financing for small-scale producers remains limited, especially in frontier markets.

Strategic Takeaways

The global Artemia market is entering a transition from resource-limited wild harvests to technology-driven farmed supply chains. Rising aquaculture demand, climate pressures, and the search for reliable, biosecure inputs are reshaping trade patterns and value creation.

While this study provides a macroeconomic and trade baseline, subsequent country-level value-chain analyses deepen the business and investment dimensions—identifying cost structures, profitability, and partnership models.

For investors:

- Invest in scalable farmed Artemia models and biomass processing ventures.
- Use offtake agreements with hatcheries and feed mills to de-risk early investments.
- Explore regional value chains and integration into circular bioeconomies.

For policy makers:

- Support infrastructure development in saline zones.
- Facilitate R&D partnerships for Artemia product innovation.
- Promote Artemia as a component of nutrition-sensitive and climate-resilient food systems.

For industry:

- Reduce Artemia input costs through better hatchery practices.
- Support producer networks and value chain formalization.
- Explore local uses of Artemia in animal feed and nutrition programs.

In conclusion, Artemia remains a critical enabler of global aquaculture expansion. While cyst demand may plateau in shrimp hatcheries, new growth avenues in marine fish, crab, pet food, and specialty human applications position Artemia as a versatile, high-potential product. Strategic investment in production, processing, and policy will be key to realizing this opportunity sustainably and inclusively.

1

INTRODUCTION AND METHODS

1.1 Background

Artemia—the microscopic brine shrimp that powers nearly all shrimp and marine-fish hatcheries—remains one of the most valuable yet least visible inputs in global aquaculture. Each year, an estimated 3,000–3,800 tonnes of Artemia cysts sustain the production of more than one trillion shrimp and marine-fish larvae, enabling seafood output worth over USD 50–60 billion.

Despite this strategic role, over 90 percent of Artemia supply still originates from fragile wild ecosystems in only a handful of hypersaline lakes—chiefly the Great Salt Lake (GSL, United States) and Caspian/Aral basins. Climate stress, salinity change, and competing water use have already cut wild harvests by approximately 40 percent in the past decade, driving sharp price volatility and periodic shortages that ripple through hatchery industries worldwide.

At the same time, rapid growth in Asian and African aquaculture has created new demand centers and an expanding market for biosecure, traceable Artemia products. Converting even 10 percent of current wild supply to farmed systems could unlock USD 50–70 million in additional annual market value while stabilizing hatchery feed costs and creating 15,000–20,000 rural jobs in saline-land regions.

This Global Artemia Market Study provides a quantitative baseline of global production, trade, pricing, and consumption patterns to inform public and private stakeholders. It focuses on *where* Artemia is produced and consumed, *how* value is created and captured along the chain, and *which* market segments hold the greatest growth potential. The study forms the first analytical pillar of the World Bank's PROBLUE Artemia Aquabusiness Assessment, to be followed by detailed country-level value-chain and investment studies.

1.2 Methods

To gather insights on Artemia production, market dynamics, and industry trends, key informant interviews were conducted with a diverse group of experts, including Artemia specialists from universities and government institutions, as well as key industry players from multiple countries. These informants provided valuable technical and market-oriented perspectives, offering insights into production practices, quality differentials, supply chain constraints, and emerging market trends. However, given the commercial sensitivity of Artemia production, access to detailed information—particularly regarding business models, pricing strategies, and proprietary production methods—was often restricted.

Many companies and individuals were reluctant to disclose key aspects of their operations due to competitive concerns and confidentiality agreements. This underscores the fragmented and guarded nature of the global Artemia trade, where information asymmetries pose challenges to transparency and sector-wide knowledge sharing. Many emerging applications in human, animal, and pet food, and other biological applications, remain in early stages, with limited market understanding.

Despite these limitations, the qualitative insights obtained from engaged stakeholders have helped contextualize production trends and identify key factors influencing Artemia markets worldwide.

The key activities used in preparing the study include

- Desk-based reviews of published literature and information gathering from a wide network of partners within public and private sector;
- Discussions with experts having relevant experience and knowledge, including some large companies and experts involved in emerging applications;
- Country-specific reviews by a group of national experts; and
- Review and synthesis of the information and data.

The analysis covers cysts, biomass, and derivative Artemia products traded globally between 2012 and 2023. Because reliable primary data on farmed production are scarce, the study uses descriptive economic simulation (DES) and expert consensus to approximate cost structures and price bands. Subsequent PROBLUE reports—the In-Depth Country Value Chain Studies and Global Synthesis and Investment Roadmap—build on this foundation to provide micro-level profitability and business-model assessments.

2

ARTEMIA PRODUCTS AND APPLICATIONS

2.1 Artemia Product Overview

Artemia, commonly known as brine shrimp, plays a crucial role in aquaculture as a primary live feed for fish and shrimp larvae. Artemia serves as a highly nutritious food source due to its rich content of proteins, lipids, and essential fatty acids. Its non-selective filter-feeding behavior allows it to adapt its nutritional profile according to the needs of the larvae being fed. This adaptability is critical in aquaculture, where optimal growth rates and reduced mortality are desired outcomes during larval rearing.

There are two main traditional Artemia products sold widely to aquaculture markets across the world—cysts and biomass—though within these categories there are many different segmented products that cater to different needs. Table 1 shows the main products produced, principally for marine fish and shrimp hatchery and nursery production.

TABLE 1: Artemia products for the aquaculture market

	Artemia Cysts	Artemia Biomass
Description	Dormant embryos of Artemia that can be stored for long periods; can be rehydrated and hatched into live nauplii (that is, biomass)	Live or harvested Artemia at various life stages, including nauplii, juveniles, and adults, that is, skipping purchasing and hatching of cysts and buying the biomass directly
Source	Harvested from natural hypersaline environments or produced through aquaculture	Cultivated in controlled aquaculture systems or sometimes harvested from the wild
Applications	Primarily used by hatcheries to produce live feed for fish and crustacean larvae; convenient for long-term storage and transport	Directly used as feed in live or frozen form by aquaculture farms, by feed manufacturers, and for research purposes; provides immediate availability of nutritious feed
Production (supply)	Globally, about 3,500 tonnes, of which, over 90% comes from wild fisheries, while the rest is farmed	Over 104,000 tonnes almost exclusively produced in China and an estimated 350 tonnes from Thailand

These Artemia products represent a vital resource in aquaculture, providing essential nutrition for fish and shrimp larvae while supporting the industry's growth. The industry also continues to innovate with advancements in processing technologies and tailored solutions for hatcheries, including early larval stages and nutrition of crustacean and broodstock nutrition.

This innovation has led to a diverse range of products that are processed and developed for various applications within the aquaculture industry, including enriched Artemia, processed Artemia cysts, and other related specialist products. The diversity of these products is illustrated in Table 2.

TABLE 2: The diversity of Artemia products in the aquaculture market

Product	Description	Key Benefit	Applications	Approximate Price	Produced	End User
Dry Cysts	Dormant Artemia embryos packaged in tins, alu-foil bags, buckets, or drums	High-quality live feed; hatchable	Hatcheries for shrimp and fish larvae	USD 86–110 per kg (varies by grade); can reach up to USD 200 if farmed and enriched	Mostly harvested from the US, Russia, China, and Central Asia	Almost all is used for shrimp and some other mariculture
Dry Cysts Coated with Iron Particles for Magnetic Separation (Sep-Art Application)	SEP-Art® Technology uses iron-coated cysts attracted by magnets to separate and collect cysts, leaving nauplii for harvesting.	Simplifies nauplii collection	Hatcheries with high throughput or labor constraints	Not widely listed; pricing varies	In Thailand and in the US	Big shrimp and fish hatcheries around the world
Dry Cysts Coated for D-fense Application (Anti-Vibrio)	Cysts coated with antimicrobial agents to reduce *Vibrio* bacteria growth	Improves biosecurity and survival rates	Hatcheries facing disease challenges, especially shrimp culture	Not widely listed; pricing varies	In Thailand	Big shrimp and fish hatcheries around the world
Dry Decapsulated Cysts	Cysts with outer shells removed for direct feeding	Easier digestion; no waste separation	Small, nutrient-rich feed or direct feeding	~USD 55 per kg	China and Russia	Catfish hatcheries in Africa
Fresh Decapsulated Cysts	Wet, decapsulated cysts preserved for direct feeding or hatching	High nutritional value; ready to use	Specialty hatcheries or farms needing fresh, ready feed	Not widely listed; pricing varies	Thailand and Viet Nam	Shrimp nurseries in Thailand and Viet Nam
Nauplii Paste, Freshly Hatched	Freshly hatched nauplii concentrated into a paste	Saves time; no hatching needed	Hatcheries and nurseries for larvae feeding	Not widely listed; pricing varies	Thailand, Viet Nam, China, India, Bangladesh, Ecuador, and other marine fish/shrimp producing countries	Shrimp, crab, and marine fish hatcheries
Nauplii Paste, Enriched	Freshly hatched nauplii enriched with nutrients (for example, fatty acids).	Boosts survival and growth rates	Intensive aquaculture systems requiring optimal larval performance	Not widely listed; pricing varies	Thailand and Viet Nam, not sure about other countries	Shrimp and marine fish hatcheries

Product	Description	Key Benefit	Applications	Approximate Price	Produced	End User
Live Adult Biomass	Fully grown adult Artemia harvested live	High protein; highly palatable	Nursery and broodstock feed in aquaculture or live feed for ornamental fish	Pricing varies	Grown almost only in China, with some farms found in Thailand	Some used in pet industry, but most goes to shrimp and crab in Asia
Frozen Adult Biomass	Harvested adult Artemia frozen for storage and feeding	Long-term storage; partly retains nutritional values	Convenient feed for aquaculture facilities, zoos, and aquariums	~USD 18–20 per kg (bulk orders)	China, Thailand, and Malaysia	Shrimp nurseries, ornamental fish
Frozen Enriched Adult Biomass	Frozen adult Artemia enriched with nutrients before freezing	Enhanced nutrition for broodstock or larvae	Advanced aquaculture systems; improved offspring quality	Pricing varies	Malaysia	For ornamental fish
Dried Biomass (spray drying, drum drying, freeze drying)	Lightweight, shelf-stable dried adult Artemia	Long shelf life; easy storage	Broodstock feed or use in aquariums, particularly for ornamental fish	~US 18–20 per kg (bulk orders)	China	For ornamental fish industry, petfood

2.2 Artemia Uses and Applications

While the primary market for Artemia cysts and biomass has been aquaculture (99 percent of market share), there is growing interest in using Artemia in various ways. Artemia's versatility extends beyond being a primary feed source in aquaculture. Data on these industries, however, is extremely lacking. There is also no clear scientific evidence of Artemia's role in animal feeds, making extrapolations difficult. Its continued use and research into its applications highlight its importance in both ecological balance and commercial aquaculture, including as:

- **Novel ingredient** in feeds for aquaculture, livestock, and poultry food due to its high protein content and nutritional benefits. However, this segment remains underdeveloped compared to traditional aquafeed applications.
- **Pet food.** Artemia is also popular in the ornamental fish industry as a food source for tropical and aquarium fish. Its availability in various forms (live, frozen, or freeze-dried) makes it suitable for different types of fish species.
- **Novel human food.** Although not widely adopted yet, there are potential applications of Artemia in human food products. Research into the nutritional benefits of consuming Artemia could open new markets, especially in health-focused food sectors.
- **Salt production.** Correct management of Artemia presence in evaporation ponds can increase the purity of the produced salt up to 99.6 percent NaCl.
- **Ecotoxicology research** including Artemia being widely utilized in aquatic toxicology as a model organism for assessing the toxicity of chemicals in the environment and bioassays.
- **Environmental monitoring.** Due to their sensitivity to pollutants, Artemia can serve as bioindicators for monitoring water quality in both freshwater and marine environments. They may help assess the toxicity of effluents before they are released into natural water bodies.
- **Biological studies.** Artemia is used in various biological research studies due to its unique reproductive strategies and adaptability to extreme environments. It serves as a model organism for studying developmental biology, cell biology, genetics, and ecology.
- **Pharmaceutical research.** The simplicity of conducting tests with Artemia makes it a valuable tool in pharmacological research, including screening for potential drug candidates and understanding toxicological effects.
- **Living filters.** In aquaculture systems, Artemia can act as natural filters by consuming excess micro-particulate nutrients from the water, thereby helping maintain water quality and reducing the need for chemical treatments.

Many of these products fulfill the demand of smaller 'niche' markets, but others have unfulfilled potential in very large markets. An assessment of these markets, starting with traditional (but large) aquaculture markets, is in the next section.

3

ARTEMIA MARKETS

The global market for Artemia is experiencing significant growth, driven primarily by the growing aquaculture industry. This section highlights the key insights into the market dynamics, trends, and challenges.

3.1 Global Market Size

The global market for Artemia products is projected to grow significantly, driven primarily by the expanding aquaculture sector. In 2022, the market for Artemia was valued at approximately USD 144 million, with forecasts estimating it could reach USD 295 million by 2030, reflecting a compound annual growth rate (CAGR) of around 9.38 percent. The demand for brine shrimp cysts remains dominant due to their resilience and ease of transportation, making them an integral component in aquaculture operations globally, with particularly high demand in Asia, which supplies ~90 percent of global aquaculture production.

The global consumption of Artemia cysts is presently estimated at 3,500 to 4,000 tonnes annually, primarily driven by the aquaculture industry, which produces over 900 billion crustacean post-larvae and fish fry valued at more than USD 2 billion. The demand for Artemia cysts has increased significantly and will continue to grow, reflecting a growing reliance on this resource for larviculture in shrimp and fish hatcheries, a traditional and dominant use of Artemia cysts and biomass. Table 3 provides further information on the Artemia cyst supplies and markets.

TABLE 3: **Artemia cysts in aquaculture: supply and market overview**

Aspect	Details
Total global tonnage and % share of cysts	About 3,800 tonnes of cysts produced, of which 99% is used as feed for aquaculture.
% breakdown harvested or farmed	90% of all cysts are harvested from the wild and 10% are now farmed.
% breakdown from source	Over 90% of *wild* cysts come from the US, Russia, and Uzbekistan, while over 90% of *farmed* cysts come from China.
Primary aquafeed markets	80% of all cysts are used for shrimp and 20% for mariculture of finfish (almost nothing for freshwater aquaculture, except some small efforts in Nigeria).
Geographic locations of markets	Top shrimp markets accounting for 80% of total tonnage: Ecuador, Viet Nam, India, China, Indonesia, Thailand, Mexico, Bangladesh, Brazil, and the Philippines (80% of whole global shrimp industry). Top finfish accounting for 20% of market: Mediterranean - Turkey, Greece, Spain, Croatia, and Italy; Asia - China, Thailand, Indonesia, Malaysia, and Taiwan, China.
Species feed breakdown (crustaceans)	Shrimp (*Litopenaeus vannamei,* pacific whiteleg shrimp; *Penaeus. Monodon,* black tiger prawn) and the freshwater prawn *Mcarobrachium rosenberghii*. The culture of several crab species (s.a. mitten crab *Eriocheir sinensis* and mud crab *Scylla paramamosain)*
Species feed breakdown (finfish)	In fish, mainly marine species are fed Artemia nauplii in the hatchery phase. The most important ones are seabream *Sparus* spp., seabass *Dicentrarchus* and *Lates* spp., and grouper *Epinephelus* spp. Others include flatfish (turbot, flounder), yellow croaker, yellowtail *Seriola* spp., and several new species s.a. pomfret, cobia, snapper spp When cheap Artemia cysts are available in the local market (less than USD 40 per kg) they have been used in catfish *Clarias gariepinus* hatcheries in Nigeria

The farmed biomass sector is less established (see Table 4) but could hold more opportunities for small-scale pond farmers and artisanal salt farmers. Currently, most biomass is produced in China, where the wild harvesting of biomass in Yuncheng Lake is unique. The biomass farming in Thailand presents an interesting case study, explored further in this report.

TABLE 4: **Artemia biomass as an aquafeed**

Aspect	Details
Total global tonnage of biomass	Estimated as 104,350 tonnes, of which 99% is harvested and farmed in China for the Chinese market.
% breakdown harvested or farmed	95% farmed and the rest harvested (though this is only unique to the Yuncheng Salt Lake in China). India also harvests some from salt lakes.
Primary market	Almost all goes into the Chinese aquaculture industry, while some producers like Thailand produce for domestic markets.
Geographic locations	No export; produced only in China, Thailand, India, and in small amounts in Iran and France.
Species feed breakdown	Shrimp, prawn, crab, lobster, occasionally marine fish nurseries (for example, *Lates* in Thailand)

3.2 Market Growth

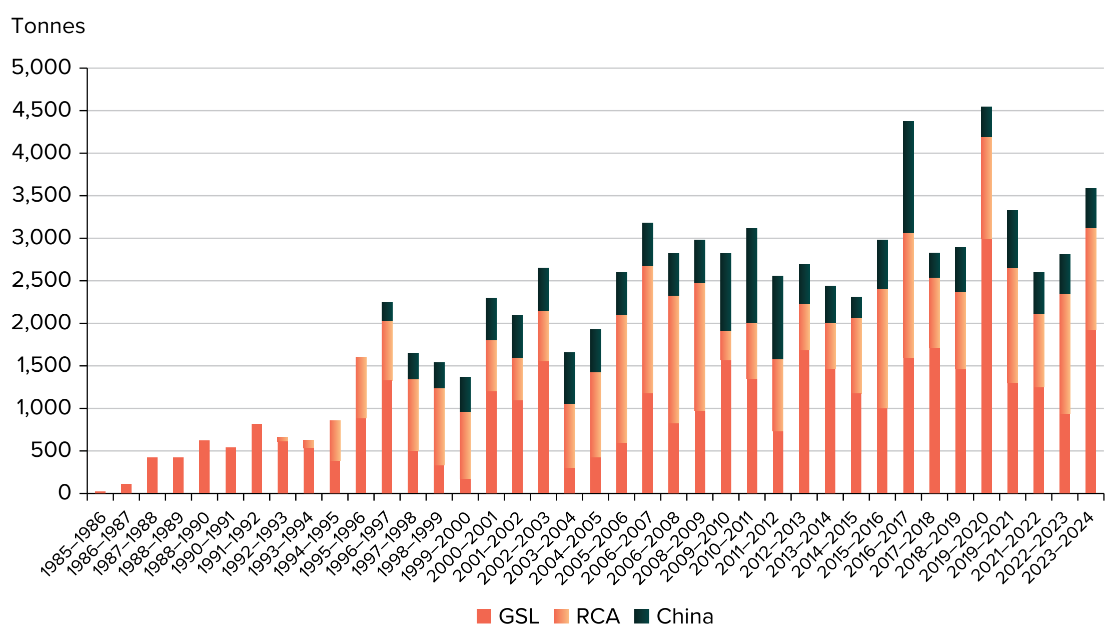
As global aquaculture continues to expand, Artemia demand is projected to expand. Estimates based on current use trends suggest 5,000 MT of cysts by 2035. This is calculated primarily on the growing shrimp and finfish mariculture sectors and does not account for potential in other sectors yet to be explored. However, meeting this additional requirement of 1,000 to 1,500 MT annually presents a significant challenge. To sustain such growth using wild-harvested Artemia, the industry would need to discover an entirely new ecosystem with the production capacity of the GSL—a near-impossible feat given the current state of global hypersaline lakes. Traditional sources like the GSL have seen a decline in output. At its peak, the GSL could produce over 50 percent of the world's supply but in the last few years this has dropped as low as 35 percent.

Hopes were once placed on the Aral Sea and Aibi Lake as viable alternatives, but climate change, large-scale irrigation projects, and human intervention have devastated these ecosystems. The once-promising lakes have been severely reduced, rendering them unreliable as commercial Artemia sources. The trends in global Artemia harvest are shown in Figure 1.

Wild-harvest yields from the GSL have declined by an estimated 35–40 percent since 2012 as water levels reach historic lows. Each 1 percent drop in harvest volume translates into roughly USD 2–3 million in global cyst price inflation, underscoring how environmental stress in a single lake can ripple through global hatchery operations. Five countries feed the world's hatcheries—three are running out of water.

Africa alone holds an estimated 2 million ha of idle saline ponds and saltpans. Converting even 1 percent (~20,000 ha) to integrated Artemia production could yield 1,000 tonnes of cysts annually—equivalent to USD 50–80 million in potential import substitution across African aquaculture markets.

FIGURE 1: Global Artemia harvest of cysts from 1895 to 2024



Source: Léger 2024, pers. comm.

Currently, no other known natural lakes possess the potential to bridge this widening supply gap. Given these constraints, future Artemia growth must be driven by farmed cyst production and increased Artemia biomass farming. The establishment of controlled Artemia production systems will be essential to securing a stable, sustainable supply chain, ensuring that aquaculture can continue to meet the rising global seafood demand.

Artemia biomass production, meanwhile, is a growing and increasingly important component of global aquaculture, serving as a primary live feed for various marine species. Currently, China is the predominant producer, accounting for approximately 99 percent of the estimated 104,350 tonnes of the global Artemia biomass, primarily utilized within its domestic aquaculture industry. Although biomass harvesting and farming started in the 1980s, it remains a unique hybrid of the two and is unique only to China.

Expanding Artemia biomass production requires specific environmental conditions and infrastructure investments. Key prerequisites include access to high-salinity water bodies free from predators, suitable climate conditions, and the availability of nutrient sources for Artemia cultivation. Additionally, establishing effective harvesting and processing facilities is essential to ensure product quality and marketability.

Thailand has a well-established aquaculture sector but remains heavily reliant on imported Artemia cysts. The country has demonstrated successful integration of Artemia biomass production with salt farming, achieving yields exceeding 100 kg per hectare per day. Countries like Senegal and Kenya, with established salt industries, could benefit from adopting Artemia cultivation practices. This integration could enhance local aquaculture, provide additional income streams for salt farmers, and contribute to food security.

3.3 Growing Supply from Aquaculture

With overharvesting and environmental changes posing significant threats to wild Artemia populations, Artemia farming is increasingly recognized as a sustainable alternative. Countries such as Viet Nam, Bangladesh, and other nations in Southeast Asia have developed artisanal farming practices that allow local salt farmers to cultivate Artemia in former salt flats. This approach not only provides an additional income stream for farmers but also helps mitigate the pressures on wild populations.

The integration of Artemia farming into salt production has proven economically beneficial. For instance, experience in Viet Nam has shown that salt farmers who also cultivate Artemia can see their household incomes nearly triple compared to those who rely solely on salt production. This dual approach enhances local economies and supports aquaculture development.

Since the early 2000s, global raw cyst farming has seen a significant increase, growing from approximately 15–20 tons to 50–60 tons annually. This growth has come from improved technologies and the expansion of farming areas, particularly in salt producing regions. In Viet Nam, for instance, yields have reached 50–250 kg of raw cysts per crop of 4–5 months, with hatcheries' demand for farmed cysts now about 400–500 tons of dry cysts each year.

It is important to note that although Artemia farming started around the 1980s, it has not really taken off until the last 10 years. The Chinese farming systems remain unique to China. Biomass farming in Thailand, although started in the 1980s as well, only encompasses about 30 farms. Cyst farming in Viet Nam may have fewer than 500 farms. Meanwhile, Bangladesh and Kenya still remain in trial phases with a handful of farmers. There are no other known active Artemia farms in the world, meaning comparisons with wild harvesting at the moment do not warrant further studies. Placing these farming systems into niche localized markets and production zones within the global market is the key and also the main focus of this report.

Regardless, farmed Artemia now represents 8–10 percent of global supply—roughly 400 tonnes per year—led by China and Viet Nam. Although small in absolute terms, this output already supports more than 150 billion shrimp post-larvae annually, demonstrating the leverage of relatively minor production volumes.

If just 10 percent of the current wild harvests were replaced by farmed supply, global Artemia trade could unlock USD 50–70 million in new market value, while reducing supply volatility and creating 15,000–20,000 rural jobs in saline-land areas. As aquaculture expands, the global Artemia trade is expected to grow to USD 500–550 million by 2035, even under conservative demand assumptions. Without parallel investment in farmed supply and quality-assured logistics, price volatility could intensify, raising average cyst costs by 30–50 percent and constraining hatchery competitiveness in emerging markets.

3.4 Geographical Insights: Supply and Market

The global Artemia supply is overwhelmingly dependent on wild-harvested sources, which account for 90 percent of the total production, with farmed Artemia contributing only 10 percent. The GSL, in the United States, remains the largest single source, contributing approximately 40 percent of the total wild-harvested Artemia (though this fluctuates yearly), with an estimated 1,500 to 2,000 MT annually. This lake has long been the cornerstone of the Artemia supply chain, supporting aquaculture worldwide. The remaining wild Artemia production originates from Russia and Central Asia, where fluctuating environmental conditions and increasing exploitation pressures create significant variability in supply. Collectively, these regions produce between 1,000 and 1,500 MT annually. Despite their importance, these wild sources face increasing threats from climate change, water management policies, and habitat degradation.

Meanwhile, farmed Artemia production remains a small but growing sector, currently contributing just 380 MT annually (10 percent of the total production). The most significant farming operations are located in China's Bohai Bay, which produces approximately 350 MT per year, or 9 percent of the global Artemia output. The Vinh Chau region in Viet Nam, while much smaller in scale, provides an estimated 30 MT per year, making up less than 1 percent of the total Artemia cyst production (Table 5).

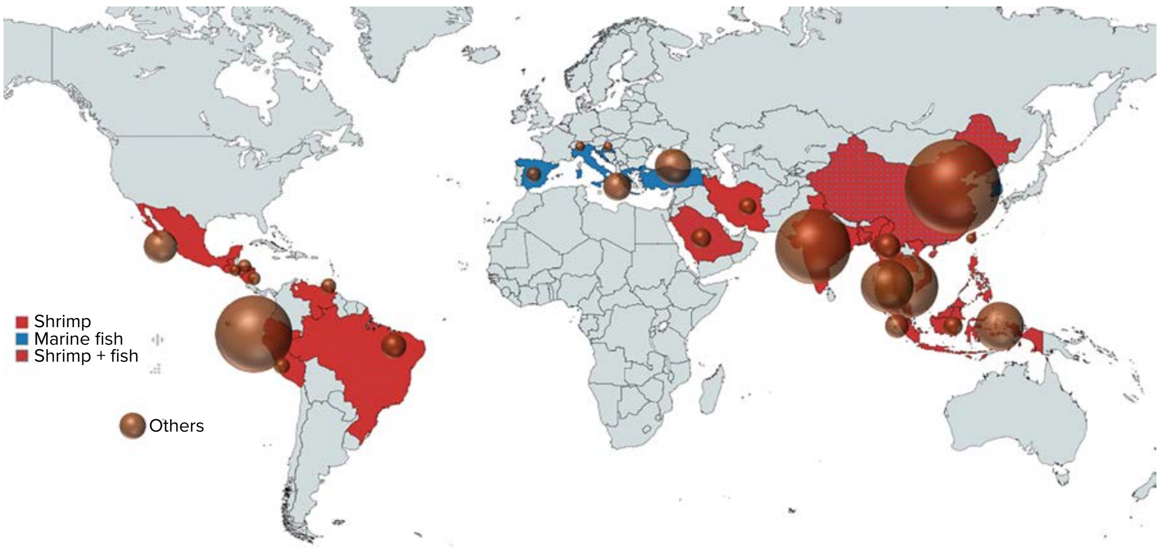
TABLE 5: Artemia cyst supply estimates (noting large fluctuations in wild fisheries)

Region	Source Type	Annual production (MT)	% of total
United States (GSL)	Wild harvested	1,500–2,000	57
Russia and Central Asia	Wild harvested	1,000–1,500	43
Total	Wild Harvested	3,500	90
China (Bohai Bay)	Farmed	~350 (between 300–500)	9
Viet Nam (Vinh Chau)	Farmed	30 (30–50)	<1
Total	Farmed	380	10
Grand Total	**Wild + Farmed Harvested**	**3,880**	**100**

Artemia biomass production from aquaculture is overwhelmingly dominated by China, accounting for over 99 percent of all farmed and harvested biomass worldwide. The bulk of this production—approximately 100,000 MT—comes from Bohai Bay, a coastal farming area in China. In addition, another 4,000 MT is produced in an inland lake, Yuncheng, also in China. Outside of China, Artemia biomass farming is relatively minor with Thailand producing about 300 tonnes from aquaculture ponds and a small amount in Mono Lake in the United States, India, and Salin d'Aigues-Mortes in France.

Biomass production almost exclusively supplies domestic markets, but Artemia cysts are widely traded globally. Figure 2 provides estimates of the global markets for cysts. The next section further explores the regional market dynamics.

FIGURE 2: Main markets for Artemia cysts in 2022[1]



Source: Léger 2024.
Note: The size of the spheres represents the volumes of Artemia used in the various markets. These are estimates based on total shrimp and/or fish production, global Artemia production, and estimates of Artemia use in shrimp and fish hatcheries.

3.5 Supply Risks and Trends

The global Artemia supply chain is facing increasing volatility, shaped by both environmental and economic risks across wild-harvested and farmed sources.

Wild Harvesting Risks

The dominant reliance on wild harvesting (90 percent of global supply) poses growing environmental and supply risks. Key ecosystems such as the GSL (United States) and lakes in Central Asia are under severe pressure from climate change, droughts, and unsustainable water management. Production from these sources is highly variable year on year and increasingly threatened by ecosystem degradation, salinity fluctuations, and regulatory restrictions. The long-term sustainability of these natural stocks is uncertain, and overreliance on a few geographies (for example, the United States, Russia, and Uzbekistan) increases exposure to geopolitical risks and trade disruptions.

1 This map is for illustrative purposes and does not imply the expression of any opinion on the part of the World Bank concerning the legal status of any country or territory or concerning the delimitation of frontiers or boundaries.

Farming Risks

Although Artemia farming is promoted as a sustainable alternative, it is not without supply chain risks. Farmed Artemia currently accounts for only ~10 percent of global supply and remains highly geographically concentrated—especially in China's Bohai Bay (90 percent of farmed production). This creates a potential bottleneck in global cyst availability should disease outbreaks, pollution events, or regulatory shifts affect production in this limited geography. Moreover, the success of Artemia farming hinges on access to suitable hypersaline environments, technical capacity, and infrastructure investment—factors that are not easily replicable at scale in many regions. Climate variability, water quality issues, and the limited number of established farms (under 250 globally) further constrain rapid scale-up.

Economic Exposure

As demand increases, especially from the shrimp and marine finfish sectors, supply constraints could drive up Artemia cyst prices, increasing hatchery operating costs and potentially limiting access for smallholders. Price volatility could also affect downstream aquaculture productivity, particularly in countries reliant on imports. Furthermore, limited global production nodes and the lack of export-oriented biomass markets outside China mean that disruptions in one country can ripple across the global aquafeed value chain. This extreme concentration exposes the aquaculture sector to climatic and political shocks: a poor harvest in one exporting lake can tighten global supply and lift prices within weeks. During 2018–2021, for example, harvest shortfalls in the GSL reduced global supply by ~20 percent, pushing cyst prices from USD 45 to USD 120 per kg and adding USD 70 million to global hatchery input costs.

3.6 Regional Supply and Demand Dynamics

Most markets across the world still depend on imported Artemia cysts, underscoring the industry's reliance on wild-harvested sources, primarily from the GSL, Russia, and Central Asia. While progress is being made in domestic production of farmed Artemia (biomass and cysts), the overwhelming need for imports reflects both limitations in local production capacity and persistent supply gaps.

China stands out as a country with substantial domestic Artemia production, generating approximately 550 MT per annum, yet it still requires an additional 800 MT from imports to meet demand (see Figure 3 and Figure 4). This indicates that even some of the largest producers cannot fully sustain their own industry and must supplement their production with wild-harvested cysts. Thailand and Bangladesh, despite their strong aquaculture sectors, produce negligible amounts of Artemia, importing 834 MT and 634 MT annually, respectively, highlighting a near-total reliance on external sources.

Viet Nam, a known site for high-quality farmed Artemia cyst production, only manages 30–50 MT per year, which is a fraction of the 470 MT it imports, reinforcing the need for expanded local Artemia farming to reduce dependency on volatile wild stocks. Similarly, India and Kenya, both emerging aquaculture hubs, import 200 MT and 50 MT, respectively, with virtually no domestic production. Box 1 provides an illustrative case study on Viet Nam where Artemia cyst aquaculture has become increasingly successful in growing in response to strong local demand.

BOX 1: DIFFERENT APPLICATIONS FOR FARMED CYST PRODUCTS IN VIET NAM

Vinh Chau Farmed Artemia Cysts - A Premium Alternative for Farmed Cysts

High nutritional value for specialized aquaculture. Vinh Chau farmed Artemia cysts from Viet Nam are a superior alternative to wild Artemia due to their higher levels of Eicosapentaenoic Acid (EPA) (20:5ω3), an essential fatty acid crucial for marine fish and crustacean larvae. Additionally, the smaller naupliar size makes them ideal for early-stage feeding, offering advantages over wild-sourced cysts, which often lack the necessary nutrient profile or appropriate size for some species. For example, mud crab larvae require 'umbrella' stage Artemia nauplii, which are only available from farmed sources. As a result, hatcheries using wild Artemia cysts face limitations, reinforcing the necessity of farmed Artemia for high-value aquaculture species.

Market demand and premium pricing. The limited supply of farmed Artemia cysts—currently restricted to Viet Nam—has resulted in extremely high prices, exceeding USD 200 per kg, significantly higher than the USD 80 per kg average for regular Artemia cysts from wild fisheries. This makes Vinh Chau cysts one of the highest-priced Artemia sources globally, alongside GSL and Bohai Bay BHB) cysts.

Potential for market expansion and cost reduction. As farmed Artemia cyst production scales and becomes more affordable, its applications will likely expand beyond specialized hatcheries. It could replace wild cysts in broader aquaculture practices, such as shrimp hatchery zoea feeding, improving biosecurity, hatchery productivity, and overall shrimp farming cost efficiency.

This import-heavy reliance presents challenges in terms of supply security, price fluctuations, and sustainability concerns, as wild Artemia fisheries face increasing environmental pressures, regulatory restrictions, and climate-driven variability. Expanding farmed Artemia production in these heavily import-dependent countries could help stabilize supply chains, reduce price volatility, and ensure long-term industry resilience. Figures 3 and 4 provide further insights into domestic markets and imports.

FIGURE 3: Domestic versus imported cysts per country

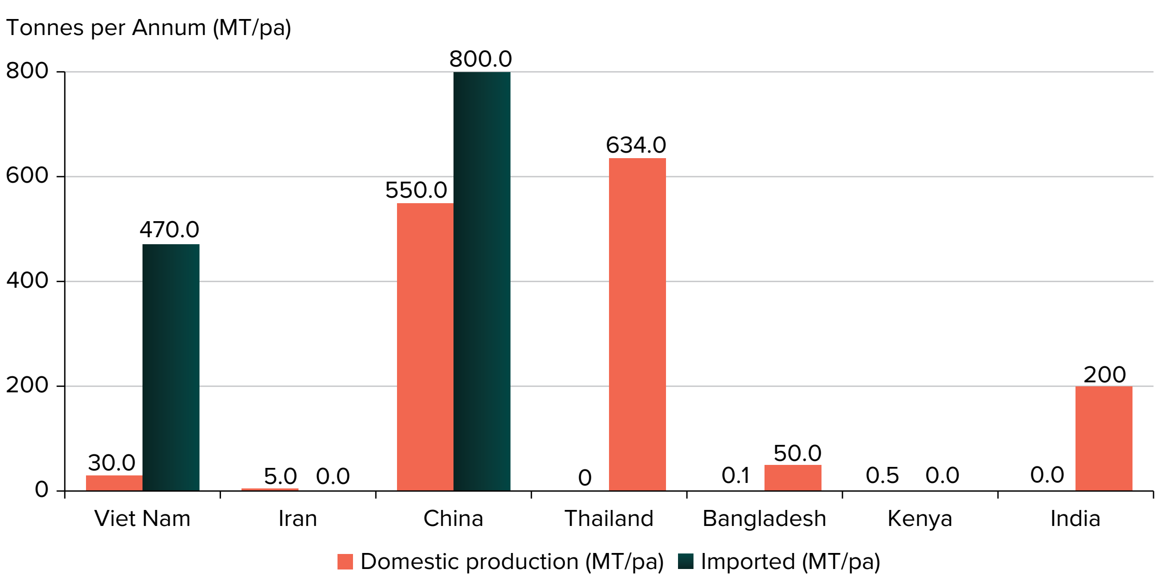
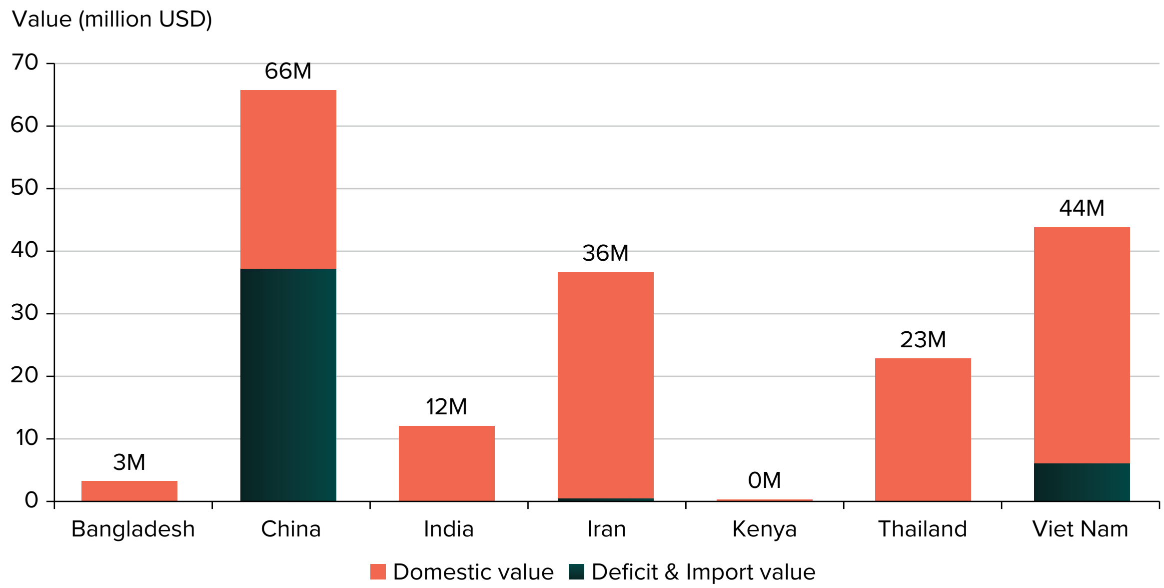


FIGURE 4: Artemia cysts: domestic values and deficits/import value



3.6 Market Drivers and Potential

The growing demand for Artemia is closely linked to the increasing consumption of seafood, with aquaculture accounting for over half of all seafood consumed globally. This trend is expected to continue as populations grow and disposable incomes rise, increasing fish supply and consumption through 2030, further driving demand for Artemia products.

Over the next decade, demand for Artemia is expected to rise due to the expansion of hatchery-based aquaculture and intensification of shrimp and marine fish farming. With the global aquaculture sector continuing to grow, Artemia requirements could increase significantly, although supply constraints and cost fluctuations may impact its accessibility. Advances in Artemia farming could help stabilize supply, while innovations in formulated hatchery feeds may also reduce dependency on Artemia in certain applications. Box 2 provides an overview of the relationship between Artemia production and shrimp farming. It highlights the amount of Artemia required to support shrimp production and the potential scalability of Artemia use in the industry, considering factors like survival rates and biomass conversion.

BOX 2: *BREAKDOWN OF ARTEMIA PRODUCTION (MT) INTO SHRIMP PRODUCTION (MT)*

Shrimp farming is growing and Artemia production will need to diversify

1. **Artemia cyst requirement for shrimp post-larvae production**
   - 2.5 kg of Artemia cysts are needed to produce 1 million post-larvae shrimp.
2. **Survival rate to harvest**
   - 50% of post-larvae survive to reach harvest size (20 g per shrimp).
   - This means 1 million post-larvae → 500,000 shrimp at harvest size.
3. **Shrimp biomass calculation**
   - 500,000 shrimp at 20 g each result in 10 MT of shrimp.
   - So, 2.5 kg of Artemia cysts produce 10 MT of shrimp.
   - This means 250 g of Artemia cysts are needed per MT of shrimp.
4. **Artemia naupliar biomass calculation**
   - 1 g of Artemia cysts hatch into 220,000 nauplii.
   - Each nauplius has a dry weight of 2 µg.
   - Thus, 1 g of cysts produces 440 mg of naupliar dry biomass.
   - 250 g of cysts would then produce 110 g of naupliar dry biomass.
   - This 110 g of Artemia nauplii supports the production of 1 MT of shrimp.

Summary

- **250 g of Artemia cysts** are required to produce **1 MT of shrimp** (assuming a 50% survival rate from post-larvae to harvest).
- **110g of Artemia nauplii dry biomass** contributes to producing **1 MT of shrimp**.

In theory, if 80% of all Artemia is used for shrimp production, then roughly 2,800 MT of Artemia could produce 11.2 million tonnes of shrimp (current production is at just under 6 million tonnes, indicating the large differences in hatchability between cyst types and shrimp survival during pond production).

3.7 Market Challenges

Artemia requirements will increase significantly for traditional uses in aquaculture, while emerging applications in human or animal feed will likely grow as well. Wild fisheries supply constraints and cost fluctuations may impact its accessibility. Advances in Artemia farming could help stabilize supply, while innovations in formulated hatchery feeds may also reduce dependency on Artemia in certain applications.

There are sustainability concerns, as natural populations of Artemia are vulnerable to overharvesting and climate change, which poses risks to future supply levels. Approximately 90 percent of current production comes from inland salt lakes, making it crucial to manage these resources sustainably. Supply bottlenecks are also a concern: despite the growing demand for Artemia in aquaculture, the supply remains relatively stable at around 3,000 MT per year, creating potential bottlenecks for expansion in aquaculture operations.

Farmed Artemia presents the only scalable solution for increasing global Artemia production, as noted earlier in this report. While there is cost-effective large-scale farming of Artemia in China, Thailand, and Viet Nam, farming can be further optimized to be a primary alternative to meet growing demand. Farming remains far behind in other parts of the world but represents an important investment opportunity to meet future demand. Beyond Artemia, the only other option for feeding aquaculture fry is the development of viable replacement feeds. It is also important to note that quality is a crucial factor, and the growth of aquaculture will need to ensure quality. Box 3 provides insights into hatchability.

BOX 3: QUALITY AND PRICING DETERMINED BY HATCHABILITY

Artemia Cyst Pricing: It Is All About Hatchability

The true value of Artemia cysts is not just in the quantity but in how well they hatch. In aquaculture, higher hatch rates mean more viable nauplii, directly influencing efficiency, survival rates, and ultimately, costs. Hatcheries are willing to pay a premium for high-grade cysts that ensure reliable production, while lower-quality cysts are priced lower due to inconsistent yields.

High Hatchability = Higher Price = Greater Efficiency

- **High Grade (>80% hatchability)** - Preferred by industrial hatcheries due to superior survival rates and faster larval development.
- **Mid-Range A (70–80%)** - Used in large-scale aquaculture, balancing cost and performance.
- **Mid-Range B (50–70%)** - Suitable for lower-grade applications, including small hatcheries and secondary feed options.
- **Low Grade (<50%)** - Often used in bulk nauplii production where hatch rates are less critical.

Wild-harvested and farmed Artemia cysts **compete on hatch performance**, with producers refining techniques to boost hatch rates and meet market demand. Every percentage increase in **hatchability translates to higher pricing**, making hatch performance the **ultimate metric** that determines Artemia cyst value.

While cysts from the GSL in the United States are considered premium, Russian and Central Asian sources require enhancement treatments. The Vinh Chau pond-produced Artemia from Viet Nam stands out due to its small nauplii size, high EPA content, and superior hatchability, commanding a premium price because it is the only Artemia type that can be used as starter food in commercial mud crab hatcheries. Table 6 outlines the key differences in quality between wild and farmed Artemia, pointing toward the value of aquaculture for farming of Artemia cysts.

TABLE 6: Artemia cyst supply estimates (noting large fluctuations in wild fisheries)

Factor	Wild Artemia Cysts	Farmed Artemia Cysts
Nutritional Quality	Variable depending on habitat, type of Artemia, and available food sources	Smaller size cysts with higher and more consistent nutritional profiles due to strain selection and controlled farming conditions
Hatchability	Inconsistent due to environmental fluctuations	More predictable and potentially higher hatch rates
Production Challenges	Subject to overharvesting, environmental changes, and regulations	Requires technical expertise, optimal strain selection, and overall farming conditions
Economic Viability	Traditionally more cost-effective but prone to supply fluctuations (due to environmental conditions)	Higher production costs (and therefore selling cost) but offers stable and sustainable supply (especially if domestically produced rather than imported)
Environmental Impact	Overharvesting can lead to depletion of wild stocks (that is, cap on yields)	Reduces pressure on wild populations, contributing to sustainability
Quality Control	Natural variability can impact consistency	Allows for biosecurity measures, selective breeding, and better control
Value proposition	Cost of production is low and established value chains make it easier to secure goods, but with high variation in supply (weather related) and larger variation in hatchability rates	Allows for more controlled production, higher nutrition and quality, and better hatchability; can also be integrated with salt farming and allow for domestic production but cost of production is high

Technological advancements and climate impacts. Artemia production remains vulnerable to environmental changes, particularly climate-induced variations in wild cyst yields. Rising temperatures, altered precipitation patterns, and reduced inflows to saline lakes threaten wild Artemia habitats. As a result, the expansion of farmed Artemia production—such as in Viet Nam and China—will play a crucial role in ensuring a stable supply. Meanwhile, hatchery feed technology continues to evolve, with some efforts focused on developing high-quality formulated replacements that could complement or partially substitute Artemia in specific production systems.

Furthermore, a substantial portion of Artemia cyst production comes from a limited number of natural sources, such as the GSL in the United States. This reliance on specific locations makes the market vulnerable to environmental changes and overharvesting, again making supply diversification to aquaculture important.

Economic pressures. The costs associated with Artemia production have been rising due to lower yields from traditional harvesting sites and the need for sustainable practices. This trend is pushing prices closer to historical highs, which could strain aquaculture operations reliant on affordable feed sources. The emergence of alternative protein sources in aquaculture is also increasing competition for Artemia producers. Manufacturers must continue to innovate and adopt environmentally friendly practices to remain competitive in a market that is shifting toward sustainability.

Regulatory and management issues. There is a pressing need for better-regulated harvesting practices to ensure the long-term viability of Artemia populations, helping to secure existing populations and wild supplies. Current practices in some regions lack oversight, leading to overexploitation and depletion of resources. Many Artemia producers face challenges related to education, financial constraints, and infrastructural limitations that hinder their ability to implement improved production methods. This gap affects overall productivity and sustainability in the industry.

3.8 Future Global Prospects

The Artemia market faces a complex array of challenges, including supply limitations, environmental vulnerabilities, economic pressures, and regulatory issues. Addressing these challenges will require collaborative efforts among stakeholders in aquaculture, environmental management, and research to ensure the sustainability of this vital resource for the growing aquaculture sector. Innovations in harvesting techniques and breeding practices are being explored to enhance Artemia production efficiency and sustainability. This includes developing new natural sources and improving cyst quality through better harvesting protocols.

As aquaculture continues to grow as a vital food sector, the demand for sustainable and nutritious live feed like Artemia will likely increase, further solidifying its role in global seafood production. In summary, while the Artemia market shows promising growth prospects driven by aquaculture demands, it faces significant challenges related to sustainability and supply stability that need to be addressed to support future expansion.

3.9 Regional Prospects and Recommendations

Emerging aquaculture economies in Africa and South Asia import Artemia products worth USD 80–100 million annually, largely from the United States and China. Replacing even 25 percent of these imports with regional production would retain USD 20–25 million in domestic value and create local processing jobs in saline-land areas.

The global Artemia value chain is unusually narrow and vertically concentrated. Fewer than 15 multinational traders and processors handle nearly 60 percent of cyst exports worldwide. The top five exporters alone—three in the United States, one in China, and one in Kazakhstan—capture roughly USD 180–200 million of the USD 320–350 million global cyst trade.

Processing and upgrading activities—cleaning, grading, decapsulation, enrichment, and packaging—add between 30 and 50 percent to the landed value of raw cysts. For premium, ready-to-hatch lots, this margin can exceed USD 70 per kg, representing USD 40–60 million annually in mid-stream value capture. In contrast, primary harvesters or small-scale producers rarely retain more than 10–15 percent of the end-market value, highlighting the imbalance between upstream production risk and downstream profit capture.

The trade remains largely opaque: prices are negotiated privately, and few formal spot markets exist. This opacity allows major traders to buffer supply shocks and maintain margins during price spikes. In high-demand years, wholesale cyst prices can rise threefold, yet producer revenues increase by less than 40 percent—the remainder absorbed by intermediaries and freight costs.

Boxes 4 to 7 summarize recommendations on market supply and demand prospects and recommendations by region.

BOX 4: EAST AND SOUTHEAST ASIA: SCALING UP ARTEMIA-SALT FARMING AND EXPORT POTENTIAL

Key countries: China, Viet Nam, Thailand, but other countries with potential, including Indonesia

Asia dominates global Artemia production, with China and Viet Nam leading in commercial-scale Artemia-salt farming. These countries integrate Artemia production with traditional salt farming in coastal regions, leveraging saline environments for cyst and biomass production.

However, despite significant domestic production, high demand and reliance on imports persist, particularly in hatchery-intensive industries like shrimp farming. Thailand, in contrast, remains largely dependent on imported Artemia despite having one of the world's largest shrimp aquaculture industries.

Key strategies for expansion

1. **Expanding Artemia-salt farming integration**
   - Strengthen policies and investment in integrated Artemia-salt farming systems to optimize land and water resources, and improve socioeconomic conditions for the poor salt farmers who might otherwise give up this activity.
   - Support small and medium-size producers with improved access to Artemia seed stock and technical assistance.
   - Encourage research on improved Artemia strains with higher yield potential.
2. **Improving hatchery efficiency through better cyst storage and processing**
   - Invest in advanced storage technologies to extend Artemia cyst shelf life and quality.
   - Promote cost-effective processing methods to improve hatchery efficiencies and reduce Artemia wastage.
3. **Enhancing export-oriented production**
   - Strengthen domestic Artemia production capacity to reduce reliance on wild-harvested imports.
   - Establish regional Artemia trading hubs to enhance price stability and supply consistency.

Challenges and considerations

- Increasing demand for Artemia cysts may outpace production if expansion efforts do not keep up.
- Environmental concerns regarding salt pan conversions and water resource management must be addressed.

BOX 5: AFRICA: UNLOCKING ARTEMIA POTENTIAL IN SALT FARMING COMMUNITIES

Key countries: Senegal, Kenya, Tanzania, Uganda, Nigeria, Ghana, Mozambique, and Madagascar

Africa has a high untapped potential for Artemia production, particularly in artisanal salt-farming regions like Senegal (and much of West Africa) as well as countries on the east coast, such as Kenya. These areas have large expanses of salt pans, which could be used for Artemia co-production. Africa alone holds an estimated 2 million ha of idle saline ponds and saltpans. Converting even 1 percent (~20,000 ha) to integrated Artemia production could yield 1,000 tonnes of cysts annually—equivalent to USD 50–80 million in potential import substitution across African aquaculture markets.

Additionally, high dependence on imported aquafeeds drives up costs for African aquaculture, making localized Artemia biomass production an important opportunity for cost reduction and feed security.

Key strategies for expansion

1. **Investing in artisanal salt farming integration with Artemia production**
   - Introduce Artemia production to existing salt farming communities to diversify income sources.
   - Provide training and capacity-building programs for small-scale farmers to transition into Artemia production.
   - Develop cooperatives that allow salt farmers to pool resources and collectively engage in Artemia sales.
2. **Developing local Artemia-based aquafeeds**
   - Encourage the use of Artemia biomass as a cost-effective ingredient in local fish and shrimp feeds.
   - Strengthen partnerships between Artemia farmers and regional feed manufacturers to ensure consistent supply.
3. **Exploring inland Artemia production in saline-affected areas**
   - Identify and assess the feasibility of Artemia farming in saline-affected inland areas where conventional agriculture is unviable.
   - Support pilot projects that explore the commercial viability of Artemia farming in these regions.

Challenges and considerations

- Infrastructure for Artemia processing and storage is currently limited in many African countries.
- Market development efforts will be required to establish consistent demand for locally produced Artemia, that is, hatcheries.

BOX 6: SOUTH ASIA: BUILDING A SUSTAINABLE DOMESTIC ARTEMIA SUPPLY

Key countries: Bangladesh and India

Bangladesh is a major shrimp aquaculture producer yet remains heavily dependent on imported Artemia cysts. In recent years, pilot projects have been initiated to explore the integration of Artemia into salt farming and local aquaculture.

Additionally, Artemia presents a unique nutritional opportunity, as its biomass has been tested as an affordable protein source to combat malnutrition in vulnerable communities.

Key strategies for expansion

1. **Scaling up Artemia farming pilot projects**
    - Transition small-scale pilot projects into larger, commercially viable Artemia farms in different regions in the country; production is now only in Cox's Bazaar, but there is potential in the Khulna Shakthira region, in Bangladesh.
    - Support research on Artemia strain selection to improve productivity in Bangladesh's saline conditions.
2. **Promoting Artemia as a nutritional supplement for malnourished populations**
    - Build on existing nutritional trials to develop scalable Artemia-based food products.
    - Engage nongovernmental organizations (NGOs) and development agencies to support Artemia biomass integration into public nutrition programs.
3. **Strengthening supply chains to reduce reliance on imports**
    - Improve Artemia cyst collection, processing, and distribution systems.
    - Develop partnerships with local aquaculture feed producers to incorporate Artemia biomass into shrimp feed formulations.

Challenges and considerations

- Artemia farming is still at a **pilot stage** in Bangladesh, requiring further validation for commercial-scale expansion.
- Consumer acceptance of Artemia as a food ingredient remains an emerging area of exploration.

BOX 7: AMERICAS: EXPANDING ARTEMIA FARMING BEYOND WILD HARVESTING

Key countries: Peru, Chile, Brazil, Bolivia, and the United States

The Americas currently rely heavily on wild Artemia harvesting, particularly in the GSL (United States) and selected locations in Latin America. While wild harvests remain a major supply source, there is growing interest in developing inland Artemia farming in salt-affected soils across Latin America (Peru, Chile, Brazil, and Bolivia).

Given the region's strong seafood export market, investment in processing and storage innovations could significantly improve the economic viability of farmed Artemia. Much of the exports from the GSL go to Ecuador and Brazil, which have huge potential for aquaculture expansion.

Key strategies for expansion

1. **Evaluating the feasibility of Artemia farming in inland saline zones**
   - Identify and assess salt-affected areas suitable for Artemia production.
   - Conduct feasibility studies on the economic viability of coastal and inland Artemia farming to reduce dependency on wild stocks.
2. **Supporting innovation in processing and storage technologies**
   - Invest in **high-quality Artemia cyst processing facilities** to extend shelf life and improve product consistency.
   - Support research into improved Artemia storage methods, particularly for long-distance exports.
3. **Developing partnerships with aquaculture industries**
   - Strengthen collaboration between **Artemia producers and hatcheries** to increase demand for farmed Artemia.
   - Facilitate public-private partnerships (PPPs) to fund Artemia production trials in new regions.

Challenges and considerations

- Suitable sites for Artemia production might not be in proximity to captive markets.
- Existing industries (desalination plants, mineral extraction industries) might have limited interest in new aquaculture activities.
- Environmental concerns regarding water resource management must be addressed.

4

NOVEL AND EMERGING APPLICATIONS OF ARTEMIA

The following sections explore the markets for new and emerging applications of Artemia, many of which are nascent.

4.1 Artemia as a Novel Ingredient in Animal Feed

Artemia, particularly in its processed forms like Artemia meal, is emerging as a promising alternative protein source in animal feeds, especially in aquaculture, poultry, and pet sectors. Beyond its use in aquaculture feeding, processed Artemia has the potential to replace or supplement fish meal in diets for larger fish or aquatic and terrestrial animal species, offering a nutritious alternative that meets their dietary needs.

4.1.1 Value Proposition

The value of Artemia as a novel ingredient in animal feed derives from the nutritional benefits of Artemia and sustainability. The nutritional benefits include: (a) Artemia is rich in protein, making it an excellent candidate for animal feeds. The protein content can also be enhanced through enrichment techniques, increasing its value as a feed ingredient; and (b) Artemia contains essential fatty acids, particularly omega-3 fatty acids, which are crucial for the growth and health of aquatic and terrestrial animals. This makes it a valuable addition to diets that traditionally rely on fish meal or other marine proteins.

The sustainability values include Artemia in the circular economy. Farming Artemia can utilize agricultural or other by-products (for example, Monosodium Glutamate production waste streams in Thailand), promoting a circular economy. This approach not only reduces waste but also provides a sustainable source of protein that can help alleviate the pressure on wild fish stocks. While life cycle analysis (LCA) research on Artemia is limited, there are indications of lower environmental impact compared to conventional marine protein sources, with potential to generate lower greenhouse gas emissions and culture from less resource-intensive farming practices. This aligns with the growing demand for environmentally sustainable feed ingredient options, including products such as black soldier fly.

Biomass—harvested as live or dried Artemia—accounts for an estimated 20–25 percent of the global Artemia trade value (USD 70–90 million annually). Major uses include live feed for ornamental fish and marine species, as well as a growing ingredient in aquafeeds and poultry feeds. Field and lab trials show that including 5–10 percent Artemia biomass in shrimp or fish feed can improve growth rates by 5–8 percent while reducing dependence on fish meal. At scale, this substitution represents a potential USD 150 million feed ingredient market by 2035. Current biomass prices range from USD 2–5 per kg for bulk dried product to USD 8–12 per kg for enriched or powdered forms. Processing and value addition (research and development [R&D] in enzymatic hydrolysis and pelletization) could double this segment within a decade.

Value Proposition

- *Cysts = 70% of market value; biomass = USD 70–90 million segment poised to double by 2035.*
- *Every 5% fish meal replacement with Artemia biomass could save the aquafeed industry USD 200–300 million annually.*
- *Human-food and pet-food applications may add USD 30–40 million new value within a decade.*
- *Average cyst prices have ranged between USD 30 and 180 per kg over the past decade, depending on origin, grade, and hatching percentage. A move toward certified, traceable farmed cysts could capture 30–50 percent price premiums, adding USD 50–60 million in annual market value.*
- *If only 10 percent of global hatcheries converted to premium farmed cysts, that niche alone could exceed USD 30 million per year by 2030.*
- *Decapsulated and ready-to-hatch cysts achieve retail premiums of 50–70 percent over raw product, and the global market for such formats could reach USD 100 million by 2030*
- *Hydrolyzed biomass and protein extracts are finding new uses in pet-food and nutraceutical applications, particularly in China, Thailand, and Europe, where demand for sustainable marine proteins is surging. If only 1 percent of the current global pet-food market adopted Artemia ingredients, it would create a USD 20–25 million new annual niche.*
- *Though still experimental, a fortified-food pilot reaching just 0.1 percent of South Asia's rural population would represent a USD 10–15 million market.*

4.1.2 Competitors

The key factor determining the use of Artemia as a novel feed ingredient will be price, and its ability to compete with other emerging novel feeds, such as black soldier fly, microbial products, seaweed extracts, and others. The limited information on production prices for biomass in Thailand suggest a production cost of less than USD 1 per kg wet weight, which is higher than Thai fish meal (USD 1–1.5 per kg dry weight), but potentially competitive with black soldier fly. Further research on production costs, product quality upgrading (hydrolyzed biomass, shorter peptides, improved digestion for piglets, and so on), and markets is required to fully assess potential, some of which will be collected during Component 2 studies.

4.1.3 Primary Market Drivers and Size

The market for aquatic feed ingredients is globally significant, estimated at USD 28.72 billion in 2022 with an expected CAGR (growth rate) at 3.4 percent per year from 2024 to 2032, to a value of USD 40.0 billion by 2032. This is a substantial market, with opportunities for Artemia that require further research.

4.1.4 Main Challenges

The main challenges are to make Artemia biomass farming more cost-effective through R&D innovations, which might include

- Use of improved strains (through selective breeding, use of all-female parthenogenetic strains);
- Cheaper feeds (enhancing biofloc production);
- Intensification of production (deeper ponds, application of aeration); and
- Year-round pond production even during the rainy season.

A further challenge will be to develop methods to maximize the nutritional value of Artemia biomass, with promising approaches including

- Direct use of live biomass paste in feed manufacturing;
- Use of hydrolyzed biomass to maximize nutritional value for specific applications; and
- Solar drying techniques.

Animal feeding tests to determine minimal cost-effective replacements of fish meal by Artemia products for specific species in specific countries are also needed, particularly where fish meal is less available and market prices for replacements are favorable.

4.1.5 Future prospects

The potential for Artemia as a novel ingredient in animal feeds is significant, driven by its nutritional benefits and sustainability advantages. Ongoing R&D efforts are crucial for establishing its viability as a mainstream feed ingredient, particularly in the poultry and aquaculture sectors. As the demand for sustainable protein sources increases, Artemia could play an essential role in reshaping animal nutrition practices globally. Innovative farming techniques will be key, perhaps building from the biomass production systems in Asia, to drive efficient farming with competitively priced products.

4.2 Artemia as a Novel Human Food or Dietary Supplement

Artemia has garnered interest as a potential human food source due to its nutritional profile and various health benefits.

4.2.1 Value Proposition

The value of Artemia as a human food, as in the animal feed markets, derives from the nutritional benefits of Artemia and sustainability, and its potential for culture in remote, salty, and climate-stressed regions, often with high populations of nutritionally compromised populations. More specific details are shown in Table 7.

TABLE 7: Value proposition of Artemia as a human food

Nutritional Profile	Health Benefits
• **High Protein Content.** Artemia is rich in protein, containing approximately 40–65% protein by dry weight, making it an excellent source of nutrition for humans. This high protein content is beneficial for muscle development and overall health. • **Essential Fatty Acids.** It contains essential fatty acids, particularly omega-3s, which are important for heart health and cognitive function. These fatty acids are crucial in reducing inflammation and promoting overall well-being.	• **Bioactive Compounds.** Artemia is known to contain bioactive compounds that may have antioxidant and anti-inflammatory properties. These compounds can contribute to improved health outcomes and may help prevent chronic diseases. • **Potential Functional Food.** Given its nutrient density, Artemia could be developed into functional food products that offer additional health benefits beyond basic nutrition.
Sustainability Considerations	**Culinary Applications**
• **Sustainable Protein Source.** As the demand for sustainable food sources increases, Artemia presents an opportunity due to its ability to thrive in extreme environments with minimal resources. Its cultivation can be more environmentally friendly compared to traditional livestock farming. • **Circular Economy Potential.** Utilizing Artemia in human diets could contribute to a circular economy by integrating aquaculture with sustainable food systems.	• **Food Products.** Artemia can be processed into various food products, such as snacks or protein powders, or incorporated into existing dishes. This versatility allows it to be marketed to health-conscious consumers looking for alternative protein sources. • **Cultural Acceptance.** While Artemia is not widely consumed in many cultures, its acceptance could increase with proper marketing and education about its benefits.

4.2.2 Competitors

As in the case of animal food, a key factor determining the use of Artemia as a novel feed ingredient will be price, and its ability to compete with other emerging novel feeds. Compared to traditional proteins like shrimp (USD 5–18 per kg) and chicken (USD 5–10 per kg) becoming increasingly unaffordable, Artemia emerges as a potentially game-changing alternative at just USD 1–5 per kg (Table 8). With a protein content of 40–65 percent—far surpassing shrimp (20–24 percent) and chicken (23–25 percent)—Artemia offers more protein per dollar while thriving in hypersaline environments, requiring no freshwater and little feed.

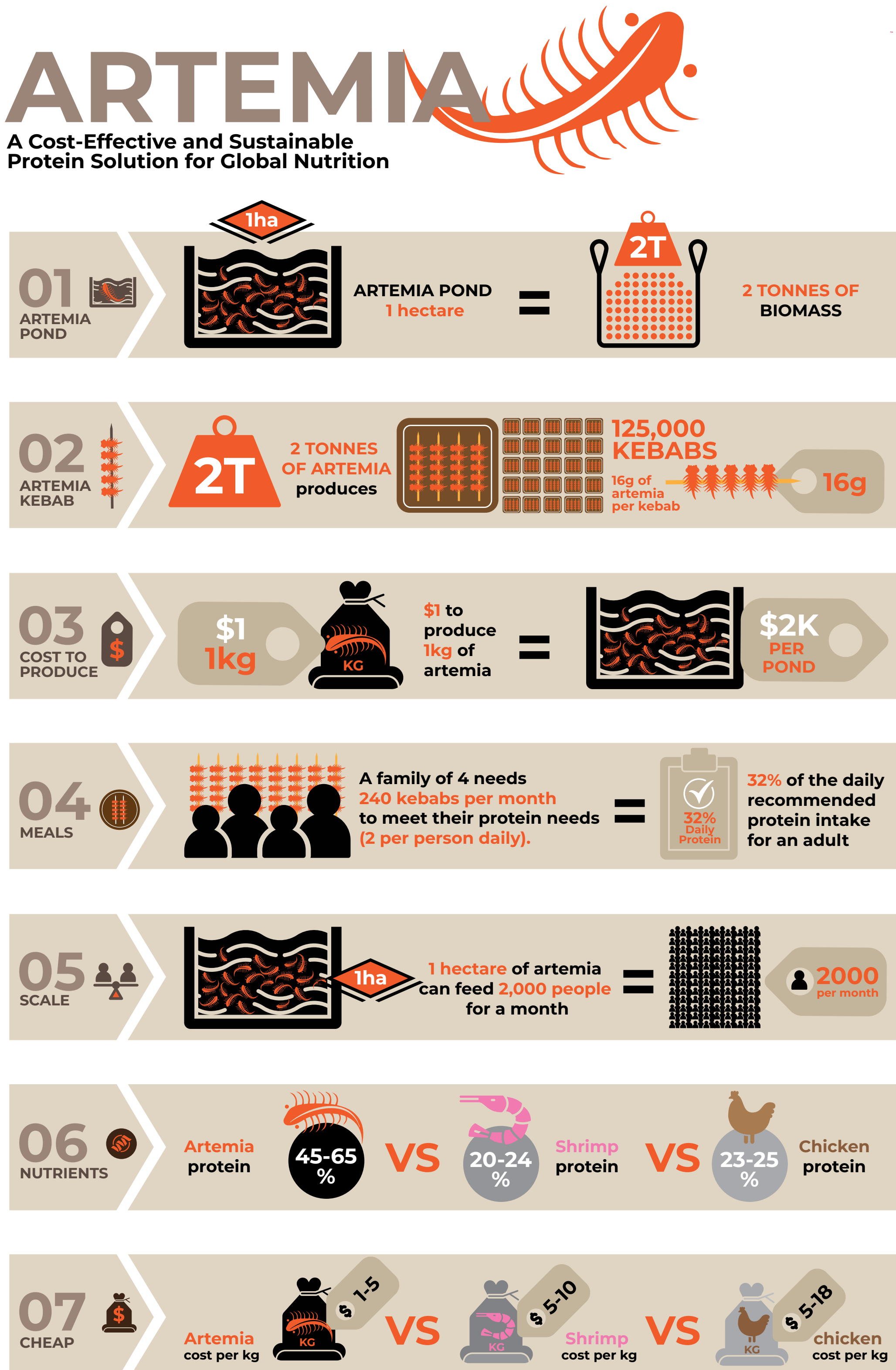
TABLE 8: Cost-effectiveness and protein comparison: Artemia versus shrimp and chicken

Factor	Artemia	Shrimp	Chicken
Cost (USD per kg)	**~1–5**	5–18	5–10
Protein Content (%)	**40–65**	20–24	23–25
Water Usage	**Low (hypersaline environments)**	High	High
Land Requirement	**Minimal**	Medium	High
Sustainability	**High**	Medium	Low

4.2.3. Primary Market Drivers and Size

There is clear potential as a sustainable, scalable, and cost-effective protein source to contribute to food security and nutrition programs in low-income regions, making high-quality protein accessible without the resource burden of traditional livestock. Some key insights into the value of Artemia for human food and nutrition are provided in Figure 5—some early work for further development.

FIGURE 5: Market insights and values of Artemia, based on Bangladesh experience



Farming Artemia for its biomass rather than just its cysts present a highly efficient and sustainable protein source with significant economic and nutritional benefits. A single hectare of Artemia ponds can yield two tonnes of biomass, which can be processed into high-protein food products equivalent to 125,000 kebabs or used as a direct feed source for aquaculture, supporting fish and shrimp production. With a production cost of just USD 1 per kilogram and a market value reaching USD 2,000 per tonne, Artemia biomass farming offers a cost-effective alternative to traditional protein sources. Nutritionally, it boasts a 45–65 percent protein content, surpassing both shrimp (20 percent protein) and chicken (32 percent protein), making it an excellent supplement for human diets. Additionally, a single hectare of Artemia production can provide enough protein to sustain a family of four for an entire month, addressing food security challenges. Compared to traditional livestock farming, Artemia biomass is a cheaper and more sustainable protein source, offering a scalable solution for both aquaculture feed and direct human consumption.

4.2.4 Main Challenges

The main challenges include food safety and regulations. As with any new food source, safety assessments are necessary to ensure that Artemia is free from contaminants and safe for human consumption. Regulatory frameworks will need to adapt to accommodate this novel ingredient. There may also be concerns regarding allergic reactions in some individuals, similar to other seafood products. Comprehensive studies would be required to assess allergenic potential.

Table 9 showcases a market growth strategy that aims to position Artemia biomass as a viable and scalable protein source for both aquaculture and human consumption by leveraging its nutritional value, sustainability, and cost-effectiveness. It outlines key approaches to expanding its market, including branding Artemia as a sustainable and eco-friendly protein, integrating it into familiar seafood products, and targeting cost-conscious and health-focused markets. The strategy also highlights the importance of business partnerships—working with shrimp and prawn processors, food manufacturers, and aquaculture companies to drive adoption. Additionally, it explores opportunities in premium health markets and convenience food sectors, ensuring Artemia-based products reach mainstream consumers. By aligning with sustainability trends, functional nutrition, and affordability, this strategy aims to establish Artemia biomass as a competitive protein alternative in global food systems.

TABLE 9: A market growth strategy to grow the human food market for Artemia

MARKET GROWTH STRATEGY Unlock business insights with effective market research strategies	
01	**Highlight Nutritional Parity or Superiorities** • Market Artemia as a low-cost, high-nutrient alternative for functional food and seafood products.
02	**Position Artemia as a Sustainable Alternative** • Partner with sustainability advocates and organizations to promote Artemia-based products as eco-friendly seafood alternatives. • Label products with certifications like 'sustainably sourced' or 'low-carbon protein' to attract environmentally conscious consumers.
03	**Introduce Artemia as an Ingredient in Familiar Shrimp-based Products** • Develop hybrid products where Artemia particularly replaces shrimp or prawn, maintaining flavor but reducing cost. • Collaborate with food manufacturers to integrate Artemia into existing shrimp-based product lines.
04	**Target Cost-Conscious Markets and Build on Artemia's Versatility** • Introduce Artemia-based food products (for example, dried Artemia powder, Artemia kebabs) targeted at markets in Africa, South Asia, and Southeast Asia. • Collaborate with governments and NGOs to include Artemia products in school feeding programs and malnutrition initiatives. • Market Artemia-based products as a functional ingredient for both traditional and modern dishes.
05	**Partner with Shrimp and Prawn Processors** • Partner with seafood companies to co-develop Artemia-enhanced shrimp products. • Highlight the potential for cost savings while maintaining product quality.
06	**Leverage Premium Health Markets** • Market Artemia as a premium product for functional foods; develop Artemia-enriched health foods like protein shakes, bars, and capsules.
07	**Enter the Ready-to-Eat (RTE) and Convenience Food Market** • Collaborate with RTE food brands to launch Artemia-based options. • Showcase these products in urban and semi-urban retail markets globally.

4.2.5 Future Prospects

Artemia holds significant potential as a novel human food source due to its high nutritional value and sustainability advantages. With ongoing research into its health benefits and culinary applications, it could emerge as a viable alternative protein option in the human diet. However, addressing safety concerns and regulatory challenges will be crucial for its acceptance and integration into mainstream food products. The nutritional aspects of Artemia will be further explored during the Component 2 in-depth value-chain studies, building from the initial assessment presented here.

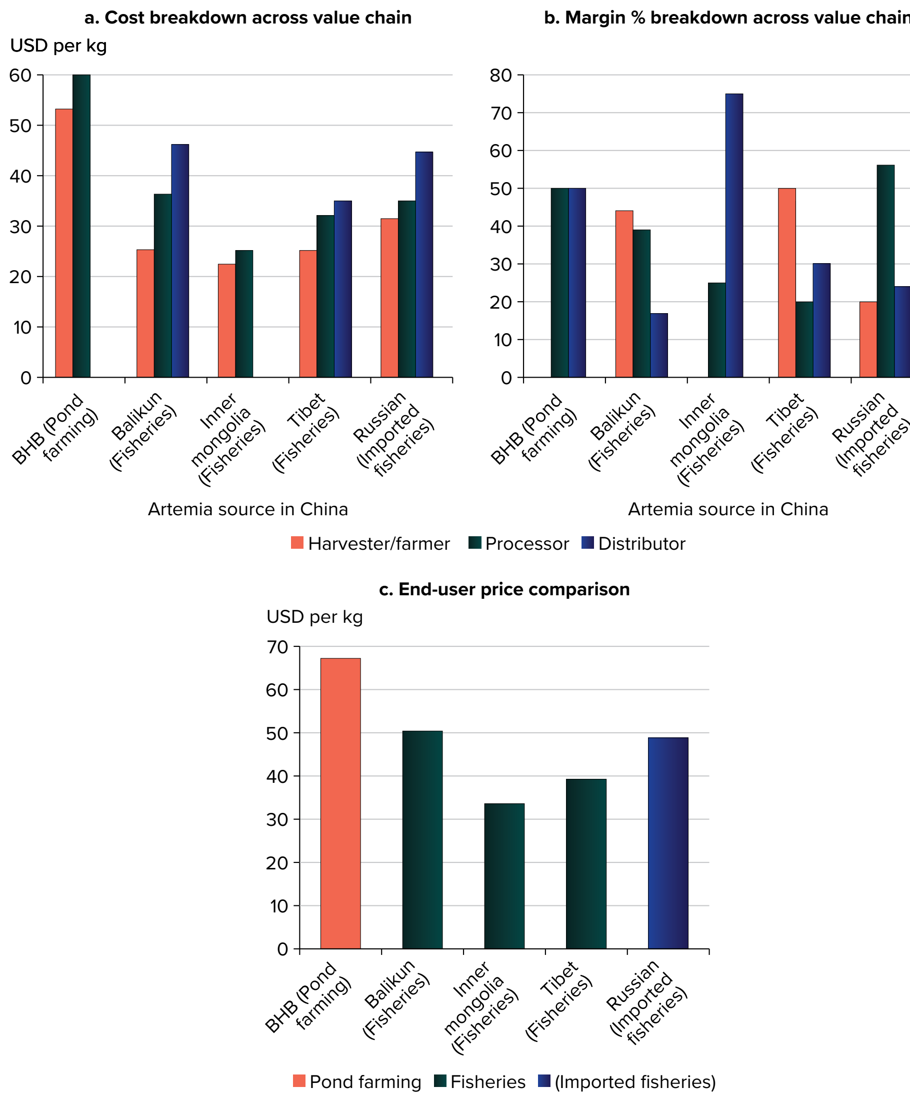
5

SELECTED COUNTRY MARKET AND VALUE-CHAIN CASES

The global Artemia market is complex, shaped by multiple production systems, sourcing regions, global trading, markets, and supply chain structures that contribute to the final price formation of Artemia cysts and biomass. China stands out as a key player, both as a major producer of farmed Artemia and as a major buyer, sourcing from its domestic pond-based and wild fisheries production, as well as from imports from Russia, Kazakhstan, and the Aral region.

Figure 6 offers a unique perspective by tracking the value addition across different points in the supply chain (using China as a case study). The analysis focuses on how value is created, captured, and distributed among farmers, processors, and distributors, shedding light on market structure, power dynamics, and supply-chain efficiencies.

FIGURE 6: Breakdown of cost (USD) per kg & margin % of Artemia cysts across the value chain from various sources and a final end-user price comparison



5.1 China: A Market of Multiple Sources

China is the leader in Artemia farming, producing over 99 percent of the world's total biomass. With its vast coastal salt ponds and inland salt lakes, China has refined Artemia aquaculture into a high-yield, high-efficiency industry that fuels its booming shrimp and fish hatchery sector.

The Bohai Bay region is the beating heart of China's Artemia production. Here, a unique mix of indigenous parthenogenetic Artemia and the introduced *Artemia franciscana* thrive in expansive salt ponds. The introduction of *A. franciscana* in the early 1990s transformed Bohai Bay into a biological engine for Artemia cyst and biomass production, capitalizing on the species' fast growth, resilience to extreme temperatures and salinity, and superior hatchability. Today, Bohai Bay alone produces over 100,000 MT of Artemia biomass annually, a staggering volume that underpins China's global dominance.

China's Artemia value chain is a delicate balance of domestic production, wild fisheries, and imports, each contributing to the country's dominance in the global market (see Figure 6). Pond farming, particularly the BHB model, has emerged as a high-value segment, commanding the highest end-user prices due to controlled production, quality assurance (QA), and structured supply chains. However, this comes at a cost—harvesters face higher input expenses, which are reflected in the price progression across the value chain. Wild-harvested Artemia from fisheries in Balikun, Inner Mongolia, and Tibet offers a lower-cost alternative, but much of the value is captured further downstream by processors and distributors, leaving harvesters with a smaller share of the total price increase (that is, the added value or total percentage margin share). Meanwhile, imported Artemia from Russia and Kazakhstan remains a cost-competitive alternative, with a more balanced price structure across the supply chain.

Despite its diversified sourcing strategy, China's long-term challenge lies in managing sustainability risks in wild fisheries and reducing reliance on imports. The chart showcasing the total share of the value add (percentage margin breakdown) highlights that, in wild fisheries, processors retain a disproportionate share of the price increase, while in farmed Artemia, value is more evenly distributed between harvesters and processors. This signals a growing shift toward structured, vertically integrated farming models, which offer greater price control and higher margin retention within domestic supply chains. The total value growth percentage remains highest in pond farming, reinforcing its investment potential despite higher initial production costs.

Looking ahead, China's Artemia sector must navigate a transition toward self-sufficiency, optimize pond farming technologies to lower costs, and improve efficiency. If successful, this shift could reduce dependency on imports, ensuring a stable, high-quality supply for China's vast aquaculture industry. However, the role of wild-harvested Artemia remains uncertain, as lake productivity faces natural limitations and the current value-chain structure leaves harvesters with diminishing economic returns. The power in China's Artemia market is increasingly shifting toward controlled farming models, and the coming years will determine whether pond farming can outcompete wild harvests and imports in both price and sustainability.

5.2 Viet Nam's Niche Artemia Industry: Quality Over Quantity

While China is the global leader in Artemia farming, Viet Nam has carved out a unique and highly profitable niche in the Artemia market. Unlike the massive commercial operations of Bohai Bay, Viet Nam's Artemia production—centered around Vinhchau-Bac Lieu—follows a more artisanal, high-value model, focusing on premium-quality cysts and biomass rather than sheer volume.

The most striking feature of Viet Nam's Artemia industry is its staggering 614 percent total value addition from production to end user, indicating a highly efficient value structure, reduced intermediaries, or premium product positioning. This contrasts sharply with China's large-scale commercial operations and suggests that Vietnamese Artemia may cater to a specialized, high-end market rather than mass production.

Viet Nam's cysts are renowned for their superior quality, boasting small size, high highly unsaturated fatty acid (HUFA) content, and high hatchability rates (H%). However, their premium pricing limits their market, making them particularly sought after in niche sectors like mud-crab hatcheries, where they can be fed directly to larvae in the umbrella stage, and for marine fish larviculture. While 80–90 percent of Vinhchau-Bac Lieu's cyst production serves local shrimp, crab, and fish hatcheries, a small but valuable share (10–20 percent) is exported to Japan and Europe, where its exceptional quality differentiates it from wild Artemia cyst sources.

Viet Nam's Artemia sector may lack the industrial scale of China, but its focus on quality, premium pricing, and niche markets positions it as a valuable player in the high-end Artemia trade. With rising global demand for specialized hatchery feeds, Viet Nam's Artemia—especially from Vinhchau-Bac Lieu—is poised to retain its status as a premium product in a competitive and evolving market.

Emerging farmed Artemia clusters in China and Viet Nam are beginning to shorten this chain. By selling directly to hatcheries or regional cooperatives, farmers retain up to 25–30 percent more value per kilogram compared with wild harvesters who are reliant on exporters. Establishing quality-assurance labs and certification hubs in producing regions could further shift USD 20–30 million of annual margin back toward primary producers.

5.3 Thailand's Artemia Industry Investment: A Sustainable Growth Opportunity

Thailand's Artemia production serves a captive and essential market, with 75 percent of biomass used in shrimp and fish hatcheries and the remaining 25 percent exported as frozen feed for ornamental fish. The strong domestic market demand and potential for expansion into high-value exports provide a compelling case for investment.

With shrimp production recovering from its 2013 disease-driven collapse, the demand for Artemia is expected to grow, making this an opportune time to invest. Shrimp production fell from 609,000 tonnes in 2011–2012 to 279,000 tonnes in 2014 but has since rebounded to 389,000 tonnes. As the industry continues its upward trajectory, the market for live Artemia biomass and frozen Artemia products will likely increase.

Thailand's Artemia market presents a strategic investment opportunity, underpinned by strong domestic demand from shrimp and finfish hatcheries and the potential for high-value exports. The integration of Artemia production into hatchery water treatment systems, as seen in Banchong Farm, offers a cost-effective, sustainable model that can be replicated across the sector. Moreover, Thailand's large livestock and animal feed industry, valued at USD 10.25 billion in 2024 and projected to reach USD 12.78 billion by 2029, provides a strong market for Artemia producers, whether for live feed or processed aquafeed applications. With the right investment, Thailand could establish itself as a regional leader in sustainable Artemia-based hatchery nutrition, catering not just to local aquaculture and animal feed markets, but also to premium export markets in Japan and Europe.

The challenges to growth, including a slow shrimp industry recovery, lack of coordination among small-scale Artemia farmers, and competition from artificial feeds must be addressed. Investing in better market organization, cooperative structures, and value-added processing facilities could enhance price stability and unlock new revenue streams. By expanding Artemia hatchery integration, developing higher-value export products, and leveraging its expertise in animal feed production, Thailand can strengthen its position in the Artemia sector, making it an attractive and sustainable investment destination for the future.

5.4 Bangladesh's Artemia Industry: A Rising Frontier for Sustainable Aquaculture Investment

Bangladesh's Artemia aquaculture is still in its infancy, but the Artemia4Bangladesh project has successfully demonstrated its technical feasibility, profitability, and social acceptance. Initiated in 2021 under the EU-funded DeSIRA program, this initiative has laid the groundwork for an integrated Artemia-salt aquaculture model that has proven to be economically viable. Over four years (2021–2024), 50 farmers across 7 hectares produced 120 kg of Artemia cysts and 11.4 MT of Artemia biomass, primarily for local hatcheries and aquaculture systems. Though small in scale, the project has highlighted Bangladesh's potential to become a significant Artemia producer, reducing import dependency while creating new income streams and employment opportunities.

Artemia biomass production has been prioritized over cysts due to higher profitability and quicker cash flow for farmers. The market for live Artemia biomass, sold at USD 4.00 per kg, is already well-established, with 20 percent supplied to shrimp hatcheries, 70 percent to fish and shrimp nurseries, and the remainder used for diet preparation in crab hatcheries and even human consumption. However, Bangladesh remains a net importer of Artemia cysts, bringing in 40–50 tonnes annually, with 90 percent sourced from the GSL (United States). Locally produced Artemia cysts, while high-quality and smaller in size, have only found a niche market in crab hatcheries, indicating an untapped potential for cyst production expansion.

The economic impact of Artemia aquaculture has been substantial, generating USD 40,000 in Artemia revenue in 2024 from 54 small-scale farms and USD 110,000 from 50 MT of integrated tilapia production. Moreover, the sector created 3,000 person-days of employment during the dry season (January–July), with women playing a critical role in Artemia processing, homestead pond culture, and feed preparation. The integration of Artemia with solar salt production has further diversified incomes, reduced risk, and increased climate resilience, as Artemia enhances water quality by consuming algae and particulates.

Bangladesh has a significant opportunity to scale Artemia production, particularly by expanding cyst production to reduce reliance on imports. Funding for technological improvements, research on Artemia as a live and frozen feed, and its potential as a fish meal replacement could unlock new revenue streams, particularly given Bangladesh's large poultry and livestock industries. The country's well-established animal feed sector provides a strong foundation for Artemia's integration into aquafeeds and terrestrial animal nutrition, presenting an attractive long-term investment prospect.

With proven feasibility, growing demand, and a strong integration model, Bangladesh's Artemia industry stands at the cusp of rapid expansion. Strategic investment in scaling production, improving feed applications, and enhancing market linkages could position the country as a key player in Artemia aquaculture across South Asia, fostering sustainable economic growth while strengthening its aquaculture sector.

5.5 Kenya's Small but High Potential Artemia Sector: Unlocking an Aquaculture Opportunity

Kenya's market demand for Artemia cysts and biomass is growing rapidly, fueled by aquaculture hatcheries, research institutions, aquarium markets, and salt producers. However, domestic production falls far short of demand, forcing reliance on imported Artemia cysts, which sell for between USD 120–300 per kg—significantly higher than the locally sold encapsulated Artemia cysts at USD 55 per kg. With an expanding aquaculture sector and increasing government support, Kenya should be ready for larger-scale Artemia production, presenting a significant investment opportunity in local cyst and biomass cultivation.

Kenya's Artemia production potential is substantial, with 6,744 hectares of salt farms available for Artemia cultivation. A single hectare of Artemia ponds can yield 33 kg of dry cysts and 250 kg of biomass, providing a scalable model for domestic production. Currently, small-scale salt-Artemia farming benefits around 350 direct and 2,000 indirect beneficiaries, with women and children reported as up to 70 percent of the indirect workforce. By expanding production, Kenya could reduce its dependence on expensive imports, making high-quality Artemia more affordable and accessible for fish farmers and hatcheries.

The country's 90 fish hatcheries require an estimated 500 to 2,000 kg of dry Artemia cysts annually, with demand projected to reach 40 tonnes by 2025 and 80 tonnes by 2030. With an increasing number of marine hatcheries under development and a rising focus on aquaculture growth, this demand is expected to grow significantly in the coming years. Scaling up local Artemia cyst production would not only meet domestic needs but also position Kenya as a potential regional supplier.

Kenya's favorable salt farm infrastructure, existing Artemia expertise, and expanding aquaculture industry create a prime opportunity for investors. Investments in Artemia hatcheries, processing facilities, and research-driven production improvements could enhance yields, lower production costs, and capture the growing cyst market. Additionally, Artemia's role in improving salt quality offers an attractive dual-purpose application for salt producers. With the right investment and policy support, Kenya could transform its Artemia sector into a profitable and self-sustaining industry, reducing import dependency, supporting small-scale producers, and driving sustainable aquaculture expansion across East Africa.

5.6 Brief Insights on the Rest of the World: Where Are the Opportunities?

Beyond the established and emerging Artemia farming sectors in China, Viet Nam, Thailand, Ecuador, Russia, Bangladesh, Kenya, and India, there are numerous other regions where Artemia farming has either been initiated, shown technical feasibility, or holds strong potential.

Figure 7 provides a visual representation of global Artemia farming opportunities, categorizing countries based on their status—ranging from initial commercial development to regions with untapped potential.

FIGURE 7: Status and potential for Artemia farming (cysts and biomass) around the world[2]

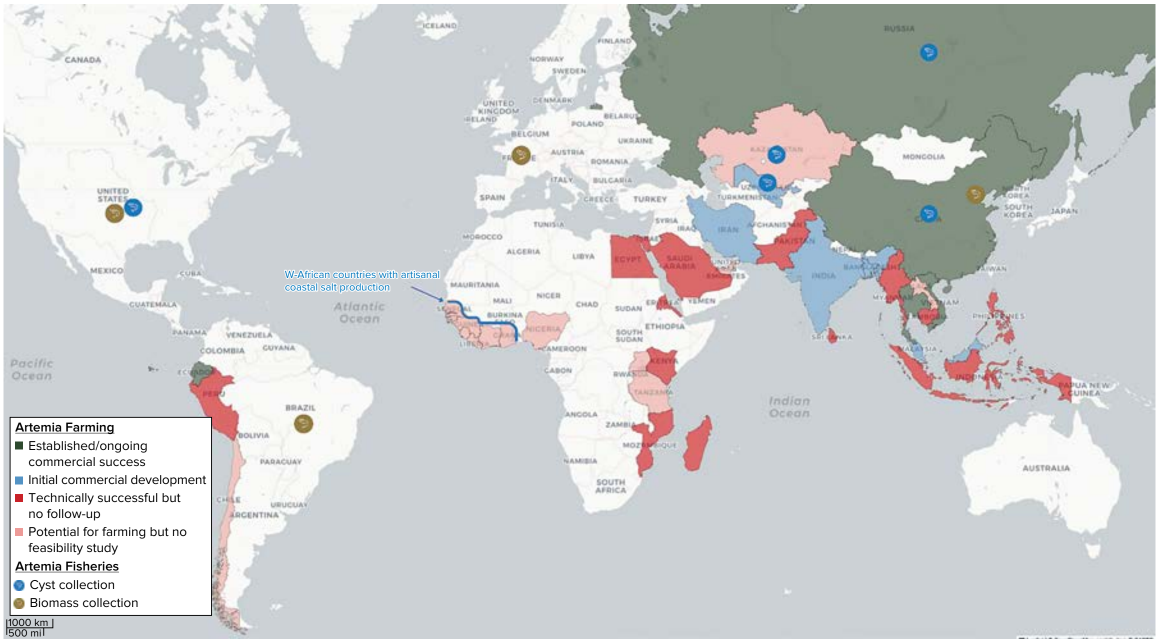


Table 10 offers quick insights into these regions, highlighting key market and production opportunities and bottlenecks that influence their potential for scaled Artemia production and investment viability.

TABLE 10: Breakdown of Artemia farming opportunities and potential by region and country

Region	Country	Opportunity	Bottleneck	Artemia Farming Potential
Central Asia	Kazakhstan	Vast saline lakes and salt-affected soils suitable for Artemia farming	Existing focus on wild cyst harvesting rather than farming systems	**Potential for Artemia Farming**
Central Asia	Uzbekistan	Large areas of salt-affected soils, saline underground waters, and infrastructure from historical Artemia harvesting	Lack of investment in aquaculture; focus on wild cyst harvest for export rather than controlled farming	**Initial Commercial Development**
East Africa	Uganda	Potential integration with salt ponds connected to alkaline lakes, supported by the aquaculture industry	No technical feasibility studies or market development	**Potential for Artemia Farming**
East Africa	Tanzania	Coastal salt pans and aquaculture development could support Artemia	Lack of Artemia farming expertise and industry linkages	**Potential for Artemia Farming**

2 This map is for illustrative purposes and does not imply the expression of any opinion on the part of the World Bank concerning the legal status of any country or territory or concerning the delimitation of frontiers or boundaries.

Region	Country	Opportunity	Bottleneck	Artemia Farming Potential
Middle East	Iran	Presence of hypersaline lakes and salt-affected soils suitable for controlled Artemia culture	Regulatory and political challenges affecting market integration	**Initial Commercial Development**
Middle East	Saudi Arabia	Large-scale aquaculture expansion, hypersaline environments, integration with desalination projects	High dependence on imports, limited local production trials	**Technically Successful but No Commercial Follow-Up**
Middle East	United Arab Emirates	Large aquaculture investments and hypersaline environments, integration with desalination projects	High production costs and reliance on imports	**Potential for Artemia Farming**
North Africa	Egypt	Artemia farming potential in coastal saltworks along the Red Sea, integration with desalination projects	Low commercial interest, preference for imported cysts	**Technically Successful but No Commercial Follow-Up**
North Africa	Eritrea	Salt pans along the Red Sea provide good conditions for Artemia farming	Limited infrastructure and hatchery market development	**Technically Successful but No Commercial Follow-Up**
South Asia	India	Expanding shrimp hatchery sector, potential in coastal salt pans	Limited awareness and technology transfer; reliance on imports for hatchery supply	**Initial Commercial Development**
South Asia	Pakistan	Large salt farming areas with potential for Artemia integration	Lack of investment and weak industry linkages	**Technically Successful but No Commercial Follow-Up**
South Asia	Sri Lanka	Several large and small salt farms; expanding shrimp aquaculture could create demand for Artemia	Competition from imported cysts; lack of local production knowledge	**Technically Successful but No Commercial Follow-Up**
Southeast Asia	Cambodia	Coastal saline areas suitable for integrated Artemia production	No established hatchery industry for local production	**Technically Successful but No Commercial Follow-Up**
Southeast Asia	Indonesia	Extensive salt farming areas with potential integration for Artemia	High reliance on imports, limited investment in Artemia farming	**Technically Successful but No Commercial Follow-Up**

Region	Country	Opportunity	Bottleneck	Artemia Farming Potential
Southeast Asia	Malaysia	Coastal aquaculture expansion, interest in Artemia as a live feed	Small-scale trials, no industry-wide adoption yet	**Initial Commercial Development**
Southeast Asia	Philippines	Solar salt farm areas; strong shrimp aquaculture sector with Artemia demand	Competition from imported cysts; weak local production supply chain	**Technically Successful but No Commercial Follow-Up**
South America	Chile	Expanding marine aquaculture sector, potential for Artemia integration, integration with desalination	Lack of Artemia farming initiatives or market demand studies	**Potential for Artemia Farming**
South America	Peru	Large area of salt-affected soils, strong aquaculture industry	No focused investment in Artemia farming despite technical feasibility	**Technically Successful but No Commercial Follow-Up**
Sub-Saharan Africa	Madagascar	Natural saline conditions in coastal areas suitable for Artemia	Lack of investment and established hatchery market	**Technically Successful but No Commercial Follow-Up**
Sub-Saharan Africa	Mozambique	Artisanal salt works, expanding shrimp farming sector could integrate Artemia	Weak technical support and aquaculture infrastructure	**Technically Successful but No Commercial Follow-Up**
West Africa	West African countries (Senegal to Ghana)	Coastal salt production could combine with Artemia farming; large aquaculture industry in Ghana	No established Artemia market or technical feasibility studies	**Potential for Artemia Farming**
West Africa	Nigeria	Large aquaculture industry could benefit from Artemia farming	No proven Artemia farming trials or infrastructure	**Potential for Artemia Farming**
Central Asia	Kazakhstan	Vast saline lakes and salt-affected soils suitable for Artemia farming	Existing focus on wild cyst harvesting rather than farming systems	**Potential for Artemia Farming**

Key Takeaways for Investment

- **Immediate Opportunities:** Countries with initial commercial success (for example, Bangladesh) need investment to scale production and develop stable markets.
- **Mid-Term Growth Areas:** Countries with successful trials but no commercial follow-up (for example, Kenya) require better industry linkages and incentives to shift from feasibility to full-scale production.
- **Long-Term Potential:** Countries in the 'more difficult' category (for example, Uganda) need feasibility studies and technical investment to evaluate their true potential.

Note: **Initial Commercial Development** - Farming has begun, showing technical feasibility, but needs scaling and market development; **Technically Successful but No Commercial Follow-Up** - Proven viability but lack of sustained investment, market, or scaling; **Potential for Artemia Farming** - No commercial projects yet, but environmental conditions suggest strong potential if investment and research were applied.

5.7 SWOT Analysis for Expansion

Strengths	Weaknesses
Offers a sustainable alternative to wild harvesting, reducing pressure on natural ecosystems. Produces higher quality cysts with consistent hatchability, smaller nauplii size, and higher nutritional value—ideal for premium hatchery markets. Can be integrated into existing salt farming operations, creating dual income streams. Provides rural income opportunities and supports inclusive aquaculture development in saline or marginal areas. Enhances domestic supply security in countries reliant on imported Artemia.	Higher production costs compared to wild-harvested Artemia; difficult to compete on price without subsidies or premium buyers. Technically demanding: requires trained personnel, specific environmental conditions, and biosecurity management. Low scalability at present—global farmed supply is <10% of market; most farms remain small-scale and fragmented. Weak domestic value chains in most new markets—limited hatchery demand, processing, or cold chain infrastructure. Regulatory uncertainty and lack of experience in aquaculture licensing for saline or inland areas.
Opportunities	**Threats**
Import substitution: countries like Kenya, Bangladesh, and India import nearly all their Artemia; local production could reduce costs and increase resilience. Rising demand for high-quality feed in shrimp and marine finfish hatcheries, especially in Asia, Africa, and Latin America. Potential to diversify into other value-added markets (for example, animal feed, pet food, human food, ecotoxicology). South-South learning and replication of successful models from Viet Nam, China, and Thailand. Potential for PPPs and donor investment in integrated Artemia–salt farming systems.	Vulnerable to price swings in the global market—wild cysts remain cheaper and can flood the market in high-yield years. Susceptible to environmental risks—Artemia requires stable hypersaline conditions, which may be affected by climate variability. Risk of market resistance: hatcheries may be reluctant to shift from familiar wild-sourced cysts to new farmed products. Competition from alternative live feeds (for example, copepods, rotifers) or improved formulated hatchery feeds. Disease outbreaks, poor water quality, or pond mismanagement could undermine reliability and farmer confidence.

6

CONCLUSION AND NEXT STEPS

6.1 Investment Prospects and Strategic Imperatives

The global Artemia market, valued at around USD 144 million in 2022, is expected to reach at least USD 295 million by 2030 and could exceed USD 430 million by 2034. This growth reflects a CAGR of approximately 9.6 percent. Artemia remains essential to the aquaculture industry, particularly hatcheries, but is increasingly constrained by environmental and supply risks. Demand is also shifting toward higher-value products, novel applications, and more sustainable, predictable farming systems.

While the cyst market for shrimp hatcheries is expected to stabilize due to improved use efficiency, new growth areas are emerging in marine fish and crab hatcheries. Freshwater aquaculture and other novel uses—including animal feed, pet food, and human nutrition—offer additional but much smaller pathways for market expansion, provided product development and regulatory validation are achieved.

The enabling environment for Artemia production remains fragmented. Only a handful of countries—China, Viet Nam, Thailand, and the United States—have formal regulations or quality standards. In most regions, Artemia falls between aquaculture, fisheries, and salt-sector mandates, creating policy uncertainty that discourages private investment. This regulatory vacuum carries a measurable cost: inconsistent quality and border delays reduce export efficiency by an estimated 10–15 percent, equivalent to USD 30–40 million in lost annual trade value.

6.2 Sector and Regional Demand Outlook (2025–2035)

Shrimp hatcheries. These account for over 80 percent of Artemia cyst usage globally, supporting the production of more than 900 billion post-larvae annually. Hatcheries are becoming more efficient, reducing cyst usage per million post-larvae through improved feeding protocols, enrichment, and decapsulation. Shrimp aquaculture is projected to grow at 4–5 percent annually, but Artemia demand is expected to remain stable or grow marginally.

Marine finfish and crab hatcheries. This segment is projected to see the highest growth. Countries such as Turkey, Greece, Indonesia, and China are expanding hatchery-based finfish production for seabass, seabream, grouper, and snapper. Demand for high-quality Artemia cysts—especially decapsulated or umbrella-stage nauplii—is rising. Crab hatcheries, particularly in Asia, are increasing demand for Artemia biomass and specialty cyst products.

Freshwater aquaculture. Emerging potential exists for Artemia-based ingredients in Clarias catfish, Nile tilapia, and Nile perch diets. While commercial trials are limited, the substitution of fish meal with Artemia biomass or hydrolysates is being explored in high-cost feed markets such as Nigeria, Egypt, and Bangladesh. This remains an innovation frontier.

Novel applications (pet food, human food). Artemia is widely used in the ornamental fish sector. In pet food, premium dog and cat food brands in Asia and the Middle East are exploring Artemia hydrolysates. In human nutrition, Artemia has shown promise in pilot studies in Viet Nam and Thailand as a protein source for nutraceuticals. Its potential in high-malnutrition regions (for example, Sahel, Bangladesh) remains underexplored.

6.3 Key Drivers of Demand

Aquaculture expansion. The sector is forecast to grow from 130 million to over 175 million tonnes globally by 2035. Hatchery-based systems—particularly for marine fish—will drive Artemia demand.

Technological improvements. Efficiency gains in cyst hatching, enrichment protocols, and decapsulation mean hatcheries can use less Artemia per unit of production.

Environmental constraints. Wild Artemia harvesting is becoming more volatile. The GSL, which historically produced 40–50 percent of global cysts, dropped below 35 percent in 2023 due to drought and salinity shifts. Other lakes are facing degradation.

Biosecurity and quality. Farmed Artemia offers advantages in traceability, pathogen control, and customization for hatchery needs.

6.4 Investment Priorities

Artemia Aquaculture

- Scale up pond farming in suitable saline environments across Africa, Asia, and Latin America.
- Target low-cost extensive systems in co-location with saltworks and aquaculture zones (for example, Senegal, Kenya, Bangladesh, Peru, and Viet Nam).
- Develop breeding programs focused on cyst traits (high hatching percentage, high EPA) and biomass yield.
- Expand hands-on hatchery training for efficient Artemia use to reduce waste and cost per larva.

Novel Products and Applications

- Invest in biomass processing (drying, paste, hydrolysates) for aquafeed, pet food, and livestock feed markets.
- Pilot Artemia as a partial fish meal substitute in tilapia, catfish, and pangasius feeds in Africa and Asia.
- Explore Artemia biomass as a protein source in fortified porridges or emergency rations in food-insecure areas.
- Promote integration with circular agriculture by using molasses, brewery waste, or agricultural by-products as Artemia feed.

Africa and Frontier Markets

- Promote Artemia production among artisanal salt farmers using low-input techniques.
- Enable domestic aquaculture hatchery inputs to reduce reliance on imported cysts.
- Strengthen local feed markets with Artemia biomass as a new protein ingredient.
- Test Artemia in community nutrition programs to evaluate its use as a local protein source for children.

Legal Recognition

Legal recognition of Artemia as an aquaculture activity would unlock access to credit lines, extension services, and environmental permitting frameworks already applied to fish farming. In Bangladesh, such recognition allowed public R&D and small and medium enterprise (SME) financing that doubled pilot output within three years. Extending similar status to saline-pond producers across Asia and Africa could catalyze USD 20–25 million per year in new production value.

Quality Assurance and Certification

Absence of standardized hatch-out testing and QA certification limits producers to bulk markets. Introducing national QA labs and voluntary certification could raise average cyst prices by 30–50 percent for compliant producers. At current trade volumes, this represents USD 50–60 million in potential annual premiums while improving buyer confidence and reducing biosecurity risk. Developing an Food and Agriculture Organization of the United Nations (FAO)-aligned *'Farmed Artemia Standard'* could mirror the success of shrimp eco-labels and open premium export channels within two to three years.

6.5 Financing Mechanisms

Blended and innovative financing structures are needed to unlock Artemia's potential:

- **PPPs:** Co-develop infrastructure in saline areas under blue economy strategies.
- **Venture capital and impact funds:** Invest in scalable Artemia innovations, such as specialty cysts, biomass derivatives, or novel feed ingredients.
- **Anchor buyer agreements:** Secure offtake from hatcheries or feed producers to reduce investment risk.
- **Development finance institution support:** Use concessional capital and technical assistance for early-stage development.

6.6 Roadmap for Action

Market and Site Scoping

- Identify 3–5 priority countries with saline zones and market access.
- Conduct environmental and commercial feasibility assessments.
- Establish local working groups with government, farmers, hatcheries, and salt producers.

Pilot and Infrastructure Development

- Launch 3–5 demonstration farms with technical partners.
- Secure offtake agreements with hatcheries or feed producers.
- Set up small-scale Artemia biomass processing units.

Scaling and Policy Engagement

- Design policy packages (tax incentives, extension, trade facilitation).
- Mobilize private investors through pitch decks and roadshows.
- Launch Artemia training and applied R&D partnerships.

Regional Integration and Investment Mobilization

- Develop national Artemia strategies linked to aquaculture or nutrition plans.
- Integrate Artemia into donor-supported aquaculture value chains.
- Support regional trade through harmonized quality standards and export pathways.

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