

VALUE CHAIN ANALYSIS IN LIBERIA

Fishery & Aquaculture

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Abbreviations

AfDB: African Development Bank

CBL: Central Bank of Liberia

CNG: Compressed Natural Gas

GHG: Greenhouse Gas

GoL: Government of Liberia

KOAFEC: Korea Africa Economic Cooperation

MoA: Ministry of Agriculture

R&D: Research and Development

SWOT: Strength, Weaknesses, Opportunities, Threats

TSR: Technically Specified Rubber

VC: Value Chain

VCA: Value Chain Analysis



Fishery & Aquaculture Sector

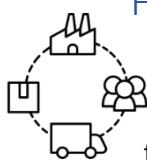
The world demand for fish and fish products shows no signs of slowing as global fish production peaked at 179 million metric tons (MT) in 2018 with both capture fisheries and aquaculture reaching the highest levels ever recorded at 96 million tonnes and 82 million tonnes, respectively. Sustainable aquaculture development and effective fisheries management are critical to maintain these trends, as well as to support recovery of wild stock populations and coastal habitats. There is growing evidence that when fisheries are properly managed, their stock is consistently above target levels or rebuilding, but where fisheries management is not in place or is ineffective, the status of fish stock is poor and will continue to deteriorate.

Aquaculture, the commercial farming and production of fish rather than the catching of species directly from oceans, estuaries and freshwater lakes and rivers, is one of the fastest growing segments in the agriculture industry globally; currently comprising 46% of the volume. Aquaculture is expected to continue growing, with the World Bank forecasting that up to two-thirds of fish consumed by humans will be farmed by 2030. Population growth and consumer preference has driven corresponding increases in per capita fish consumption, which reached 20.5 kg in 2016 and is expected to follow an average increase of 1.5% per year. Currently a segment worth \$263.6 billion USD, the Food and Agriculture Organization (FAO) predicts a further 25% increase in the price of aquaculture products by 2030¹.

Liberia’s extensive coastline and continental shelf comprises of 20,000 km² of fishing and 200 billion cubic meters of renewable inland water resources, a stark comparison to the availability found elsewhere in the region². However, only 25% of the fish consumed in Liberia is produced domestically despite the immense potential for marine and inland fishery and aquaculture development; the country currently imports in excess of 25,000 tons of fish and fish products annually. There is considerable local demand for fish in Liberia, with a 2020 consumption level of 11.42 kg per capita³, higher than the regional average. Fresh fish, particularly aquaculture fish such as tilapia, is a main protein source for the population; the market is also dominated by a pelagic sardinella fish, known locally as “bonnie” or “bonnie tongue”. Liberia holds a comparative advantage in fishery and aquaculture development relative to its regional trade partners due to the ample capacity for production, with low land usage and abundant water resources.

Country	Inland water resources (billion cubic meters)
Nigeria	221
Liberia	200
Cote d’Ivoire	77
Mali	60
South Africa	45
Ghana	30
Kenya	21

Fishery & Aquaculture Supply Chain



Liberia is home to a wide range of fish and crustacean species consumed in the country and the sub-region; however, the small fleet sizes and lack of fishing equipment means that most fishermen capture only a few species of fish and crustaceans with limited profitability. Marine fishing in Liberia is concentrated in three main areas in the country—Robertsport,

¹ FAO, 2018

² <https://data.worldbank.org/indicator/ER.H2O.INTR.K3>

³ National Fisheries and Aquaculture Authority (NaFAA) Research and Statistics Division

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Monrovia (West Point/Banjor), and Marshall—which together hosts up to 80% of Liberia’s entire coastal fishing population. Marine fisheries constitute the main source of fish production in Liberia.

The fishery sector can be divided into its artisanal fishing activities (both marine and inland fishing), which dominate the sector, and its industrial fishing activities (marine fishing only). The artisanal subsector is comprised of an estimated 13,000 fishermen and 18,000 post-harvest handlers and processors along the Liberian coast, and their fleet consist of roughly 3,000 canoes. Artisanal fishing is concentrated in Montserrado and Grand Bassa, and takes place year-round while experiencing seasonable variations in the species of the catch. There is also an influx of Gambian, Malian, and Senegalese fisherman to both marine and inland river fishing in the artisanal sector, who take their catch out of the country for selling. Liberia’s industrial fisheries were decimated during the civil war. In recent years, trawling was done using vessels ranging in number between 20 and 45, with the majority of vessels being foreign-owned (from China, Japan, the Republic of Korea); local communities were involved only as hires for deck staff and on-vessel workers. Today, only six industrial trawlers currently operate in Liberia’s marine fisheries, producing 5,634 tons of products in 2019 and 5,113 tons in 2020. There are also 56 tuna vessels operating in the marine fisheries with a total production of 9,691 tons; however, these products did not land in the country due to a lack of fishing piers for vessel docking.

To curb illegal, unreported, and unregulated (IUU) fishing, a four-year ban was instituted on industrial fishing and a 6-nautical mile inshore conservation zone was established. These measures have altered the situation favorably for artisanal fisheries, and have significantly reduced illegal fishing (by 83% in the last five years), and Liberia is the only country in the region now experiencing some level of fish stock recovery.

Aquaculture operations exist in very small numbers in Liberia. The National Fisheries and Aquaculture Authority (NaFAA) operates two hatcheries in Bomi and in Grand Gedeh. Surveys conducted by the NaFAA found that there were only 300 fish farmers in Liberia, overseeing 1,704 ponds of which only 66% or 1,125 ponds were in use. Annual production is currently around 40 MT, with farmers producing mostly tilapia and catfish; however NaFAA predicts that aquaculture has the potential to produce 15,000 MT of fish annually by 2030 if key challenges can be addressed: inadequate knowledge and human capacity; undiscerning transfer of traditional crop agriculture practices into aquaculture (e.g. seed recycling); poor species identification and broodstock management; low government budget for aquaculture development; donor-dependence with no sustainability planning.

Fish and fish products suffer significant loss in quantity and quality in Liberia during transport due to a lack of infrastructure, onboard and onshore ice supply, and poor post-harvest practices. Many fishing communities in the country do not have proper road access to markets, which results in product spoilage during the extensive transportation period. Due to poor road infrastructure, the transport of fish and fish products is very difficult and costly. Localized feed and fry production could mitigate transportation issues, particularly if farmers seek to operate in areas where there is high purchasing power, such as around mining operations. In local markets, fish is generally sold by retail by the piece, with sizes of 250 grams and higher found in the marketplace. Larger fish are preferred by do not necessarily sell for higher price per kilogram.



Investment Opportunities

Aquaculture: Tilapia

A number of different culture systems are used in aquaculture. The systems of production vary by the degree of aquaculture containment and its exposure to the external environment, and thus vary in their production risks. Farmers may use ponds, tanks, nets, bags, or cages as part of either a closed system, a semi-closed system, or an open system.

	RAS	Ponds	Cages
<i>Description</i>	<p>Self-contained systems including the Recirculation Aquaculture Systems (RAS) and indoor aquaculture systems that can sterilize all intake water before use and for reuse.</p> 	<p>Semi-closed systems include ponds (i.e. holes in the ground filled with water) where the culture is largely protected from external threats.</p> 	<p>Open systems are cages or open-water mollusks farms for oysters and mussels, which are greatly influenced by events in the external environment.</p> 
<i>CAPEX</i>	Very high	Medium	High
<i>OPEX</i>	Very high	Low to medium	High
<i>Type of feed</i>	Extruded pellets	Natural, raw feed ingredients and extruded pellets	Extruded pellets
<i>Stocking densities</i>	High	Low to medium	Medium
<i>Environmental risk</i>	Low	Low	Medium
<i>Disease risk</i>	Low	Low to medium	Medium
<i>Technical risk</i>	High	Low	Low
<i>Production (\$/kg)</i>	High	Low	Medium

The most common system found in inland and brackish water is the use of ponds. Intensification in pond farming can greatly influence production by improving the amount of seed input (i.e. the stock density) and feed, and by employing technologies to properly manage these inputs; this approach can be further categorized: the use of extensive, semi-intensive, and intensive systems.

(i) Extensive systems

These ponds use basic infrastructure to operate in an earthen pond and do not require any external addition of feed and have minimal stocking density. The system depends on food that is naturally created in the aquatic environment, such as phytoplankton and zooplankton, which can be supplemented with fertilizers.

(ii) Semi-intensive systems

These ponds also depend on naturally created food, but require some external addition of feed to supplement operations with higher stocking densities.

(iii) Intensive systems

These ponds are reliant on artificial feed, more sophisticated technology and infrastructure, and operate with high stocking densities to achieve economies-of-scale. These types of ponds are often lined with plastic sheets to facilitate waste removal, and require good wastewater treatment to control diseases. Most cage farming can be considered to be intensive. Newer operations now focus on low-density production to improve health of the fish and to ensure sustainability of the surrounding environment.

Over 10 million MT of fish and seafood is produced annually in sub-Saharan Africa (SSA), comprising of 35% freshwater fish and 65% marine⁴. The entirety of the freshwater fish is consumed within SSA while 1 million MT of the marine fish is exported. Almost all fish production is caught by fishermen, and fish farmers account for only a fraction of the total. A 2019 study by WorldFish estimated that growth of the aquaculture sector in Africa will lead to an increase in per capita fish consumption to 11.7 kg by 2030 and to 13.5 kg by 2050. If these projections are considered along with the United Nation’s median variant population growth projections for SSA, the demand for fish and seafood is forecasted to reach between 16 million and 29 million MT by 2050. Due to depleting wild stock, production from wild-caught fisheries is expected to plateau and begin its decline. According to Kontali industry reports, fish from aquaculture will grow much faster than other sources of animal protein, with a 2014-2024 supply CAGR of 2.8%. Aquaculture in SSA currently focuses on freshwater fish; freshwater fish farmers account for 17% of all freshwater fish output and this proportion is steadily increasing.



Compared to meat production, aquaculture produces a much lower environmental footprint in terms of freshwater use, land use, and CO₂ emissions. It is therefore recognized as one of the most efficient ways to produce animal protein. As a significant source of daily animal protein for a large portion of the global population, fish plays a key role in addressing hunger and malnutrition. It is worth noting that per capita fish consumption in developing countries is double that in developed countries.

Aquaculture development is therefore essential to meet rising consumption and preserve wild fish stock and coastal habitats, and is a strategic investment area for those looking to invest in food production methods of the future. As an alternative to dependence on imported fish, freshwater aquaculture, specifically tilapia cultivation, can play an important role in accelerating growth in the aquaculture segment to meet rising demand.

⁴ FAO

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Many tilapia species are native to the river and lakes in SSA or are introduced into waters where wild catches are declining. Tilapia is the most consumed freshwater fish in SSA, found widely in fish markets and forming an integral part of the

population's diet. Against the backdrop of growing demands for protein in general, consumer preference for fish in particular, and to capitalize on the expected shortfalls created by declining wild stock, there exists an opportunity for fish farmers to rapidly scale up tilapia production.

With abundant renewable water resources, Liberia enjoys highly favorable conditions for small-scale aquaculture. The NaFAA predicts that aquaculture has the potential to produce 15,000 MT of fish annually by 2030. Surveys conducted by the NaFAA found that there are only 300 fish farms in Liberia; their average in-use hectare was 73.3 and the average pond size was 464 m². Annual production is currently around 40 tonnes and is made up of five main species: Nile tilapia, African catfish, sampa, mango tilapia, and red belly tilapia. Nile tilapia and other tilapia varieties account for 93% of the production.



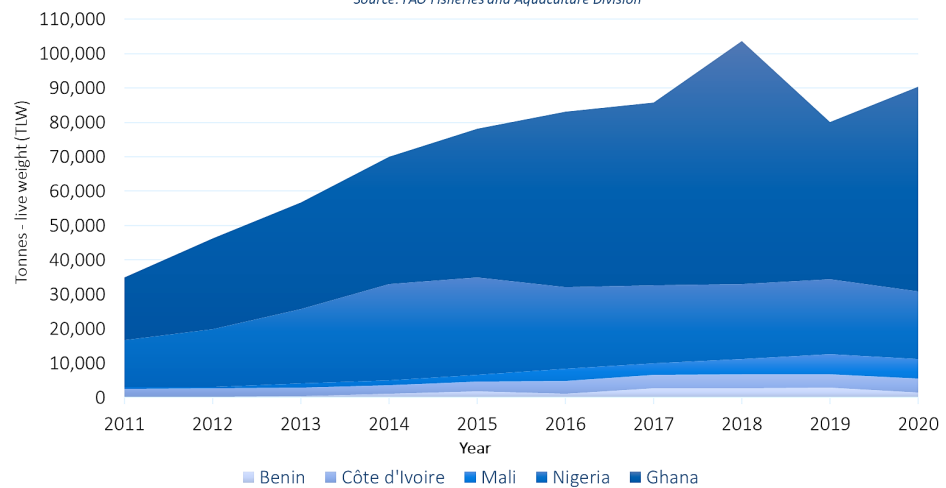
Fish is generally sold by retail by the piece, with sizes of 250 grams and higher found in the marketplace. Larger fish are preferred by do not necessarily sell for higher price per kilograms. Farmers report a preference for tilapia when fish sizes are comparable. Tilapia prices have seen a surge over the past ten years, with values in Monrovia growing from \$1.78/kg in 2011 to \$3.50/kg in 2015, a YoY price increase of 96%. Today, the price of tilapia retails above \$5/kg and given the prevailing economic headwinds and projected decline in wild caught fish, plenty of runway exists for future price growth.

In 2018 Liberia imported around 28,000 MT of fish, with an estimated market value of \$60 million USD; replacing imports with domestic aquaculture can generate significant income gains and support sustained growth of the fishery sector⁵.

There is significant demand for quality fresh fish, as well as for processed products such as fillets and smoked fish in the retail and tourism and hospitality market. Per capita consumption in 2020 was 11.42 kg, a level higher than the regional average; data from the NaFAA further suggests that consumption may be as high as 15 kg per capita, and is highly influenced by the amount of fish imported into the country. This highlights an unsaturated per capita consumption figure and a high corresponding domestic market ripe for growth.

West Africa Tilapia Production (2011-2020)

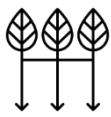
Source: FAO Fisheries and Aquaculture Division



⁵ <https://allafrica.com/stories/202110200213.html>

Key Takeaways

With an abundance of renewable inland water resources which rival that of Nigeria and a growing domestic and regional market for fish and fish products, Liberia enjoys many fundamental conditions for a highly profitable aquaculture sector. Given the intensity of production in ponds or cages and assuming a productivity above 300 tonnes of live weight per hectare, aquaculture offers highly favorable returns relative to land resource use when compared to competing agricultural crops and activities. Although Liberia has the potential to produce aquaculture valued at over \$30 million USD per year, its natural comparative advantage relative to its regional trade partners is hampered by insufficient infrastructure and limited processing and cold storage facilities. Holistic investments across the entire aquaculture business model is needed for the subsector to achieve its income-generating potential in the domestic, regional, and global market.

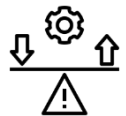


Investment Impacts

Investments in aquaculture can generate the following impacts:

- 1) Directly contributes to food security in Liberia
- 2) Provision of affordable fish and fish by-products into local markets for low-income consumers, helping to address protein deficits and related diseases
- 3) Population benefiting from a sustainable fishing practice, including through job creation
- 4) Increased protection of life under water from sustainable fishing practices
- 5) Addresses climate change and reduces environmental impact if fish production replaces meat and livestock activities that have higher emissions

Investment Risks



Production Risks

- Disease occurrence
Aquaculture diseases often result from traditional small-holder farming practices that utilize limited technology and infrastructure for disease prevention.
- Farm Performance
A well-functioning farming system improves performance and chances for success. In general, the farming system needs to provide a suitable aquatic environment for animal growth. Among other tasks, it must supply seed and feed for growing animals and manage water to remove waste and unwanted organisms. Good systems lower production risk.
- Feed and Quality Management
Most aquaculture production systems use external feed. Since feed often represents the largest cost item in aquaculture, it offers opportunities for cost saving that can reduce quality and performance. However, high feed quality is important to mitigate risk.
- Water Quality Management
Water quality is an extremely important element in aquaculture. Proper management of oxygen, ammonia and water salinity levels is essential for the health and production of fish.

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Market Risks

- Price Volatility
- Market substitutes

Environmental Risks

- Carrying Capacity
Aquaculture carrying capacity refers to the maximum amount of biomass that can be sustainably farmed in a specific operation and ecosystem. Limits to carrying capacity usually involve limits to pollution and sufficient food sources for key species.



Fishery Value Chain Structure

There is considerable local demand for fish in Liberia; in 2020, consumption was 11.42 kg per capita, a level higher than the regional average. Fresh fish, particularly aquaculture fish such as tilapia, is a main protein source for the population; the market is also dominated by a pelagic sardinella fish, known locally as “bonnie” or “bonnie tongue”. The current low fish consumption observed is attributed not to a lack of demand but to low yields and inadequate local supply. Supply-side challenges today include low availability and high costs of inputs, low processing capacity, and difficulty with market entry linked to competition with foreign operators.

Production & Sales

Liberia is a basin country in the Gulf of Guinea, at the north-eastern part of the Atlantic Ocean. Marine fishing is concentrated in three main areas in the country—Robertsport, Monrovia (West Point/Banjor), and Marshall—together hosting up to 80% of Liberia’s entire coastal fishing population. The lack of centralized data collection means that actual production figures vary depending on the source of the information; however it is generally accepted that marine fisheries constitute the main production source with more than 18,000 tonnes in 2020. Freshwater fish sourced from inland waters constitute the second largest source of catch.

The fishery and aquaculture sector can be divided into its artisanal fishing activities and its industrial fishing activities. Artisanal fishing involves both marine and inland fishing (aquaculture and river or lake fishing), while industrial actors focus exclusively on marine fishing. Artisanal vs. industrial fishing is also differentiated by the type of equipment used, the distances travelled by the operators from the coast, as well as their on-board/offboard post-harvest and processing capabilities. The fishery sector is dominated by artisanal rather than industrial fishing.

It is estimated that 13,000 fishermen and 18,000 post-harvest handlers, processors, or households participate in artisanal fishing across 139 communities along the Liberian coast, with a fleet size of roughly 3,000 canoes, most of which are not motorized. Artisanal fishing is concentrated in Montserrado and Grand Bassa, and takes place year-round while experiencing seasonable variations in the species of the catch. There is wide variation in skills, equipment and methods used between fishermen, with a division seen across tribal affiliations. The Fanti prefer to use canoes fitted with outboard motors to travel between 6-12 nautical miles from shore; the Kru and Popoh stay within 6 nautical miles from shore due to restrictions in their equipment. There is also an influx of Gambian, Malian, and Senegalese fisherman to both marine and inland river fishing in the artisanal sector, though their catch are taken out of the country for selling and thus are not integrated into the local economy.

Liberia’s industrial fleet was once amongst the top performers in Africa, with the highest export by value in fish and crustacean products. However, the sector’s infrastructure was decimated and many fishery operators emigrated during the civil war. While trawling has resumed since the end of the war, there is a shortage of a skilled workforce. Today, trawling is generally done using vessels ranging in number between 20 and 45, with the majority of vessels being foreign-owned (from China, Japan, the Republic of Korea); local communities are involved only as hires for deck staff and on-vessel workers. Trawling companies are engaged in landing catch, freezing, and trans-shipping products to other ships at sea. Since 2009, most trawling companies have ceased operations and are instead using their cold storage and landing facilities for fish imports, notably at Monrovia’s Freeport. Six industrial trawlers currently operate in Liberia’s marine fisheries, producing 5,634 tons of products in 2019 and 5,113 tons in 2020. There are also 56 tuna vessels operating in the marine

fisheries with a total production of 9,691 tons; however, these products did not land in the country due to a lack of fishing piers for vessel docking.

Underperformance of the fishery sector has been attributed to biological and economic overfishing. Poor governance along with illegal, unreported, and unregulated (IUU) fishing has led to the loss of an estimated \$1.3 billion USD per year in legal revenue for Liberia and the West African region. Through the West Africa Regional Fisheries Project (WARFP) funded by the World Bank, a four-year ban was instituted on industrial fishing and a 6-nautical mile inshore conservation zone was established. These measures have altered the situation favorably for many artisanal fisheries, which were hit hard by near-shore trawling. These efforts have also helped to significantly reduce illegal fishing significantly (by 83% in the last five years), and Liberia is the only country in the region now experiencing some level of fish stock recovery.

Liberia is home to a wide range of fish and crustacean species consumed in the country and the sub-region. However, the small fleet sizes and lack of equipment and other inputs in Liberia means that the majority of fishery operations capture only a few species of fish and crustaceans and have limited profitability. Recovery in the country's fish stock indicate potential for the expansion of the country's fishery sector, but significant investments are needed in order to fully realize export competitiveness and to meet domestic demand through local production.

Aquaculture

Aquaculture was introduced in Liberia in the 1950s but has not seen significant growth despite an increasing demand for aquaculture and other favorable conditions for the subsector.

There is interest in the government and among development partners to restore government-operated hatcheries and to rehabilitate dormant ponds. A World Bank project from 2010-2013 was implemented by the Association Pisciculture et Développement Rural en Afrique (APDRA) in Bong, Lofa, and Nimba, which introduced an approach to integrate fish farming with rice production, focusing on the indigenous African arowana fish, catfish, and tilapia. The use of fertilized livestock waste as feed helped fish farmers to produce 3 MT per hectare per year. Another aquaculture project funded by FFP, HANDS, was implemented in NaFAA hatchery in Grand Gedeh, originally constructed with support from the European Union in the 1980s. The project supported the construction of a fish processing facility at the hatchery to gut, clean, sort, and package fish for transport and composting for organic fish feed. A solar dryer was also installed for fish preservation. Peace Corps projects have produced some progress in aquaculture, with the construction of fish stations funded by the European Union. Other donors and non-government organizations continue to fund some aquaculture activities in Liberia.

There are currently hatcheries operated by the NaFAA in Klay, Bomi and in Zwedru, Grand Gedeh; a previous site in Tassah, Bong has ceased operations. No private sector hatcheries exist in Liberia. Surveys conducted by the NaFAA found that there were only 300 fish farmers in Liberia, overseeing 1,704 ponds of which only 66% or 1,125 ponds were in use. The average pond size measured at 464 m². Counties with the largest average pond sizes were Lofa (786 m²), Bong (717 m²), Margibi (713 m²), Bomi (704 m²), and Nimba (527 m²). Maryland had the smallest average pond size at 200 m². A total of 114 hectares were estimated nationwide across all 1,704 existing ponds, and the average in-use land was 73.3 hectares. Nine counties which contain almost 90% of the fish farms reported using only fresh water: Gbarpolu, Grand Bassa, Grand Cape Mount, Grand Grand Gedeh, Grand Kru, Margibi, Maryland, River Gee and Sinoe. Annual production is currently around 40 metric tons, with

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farmers producing mostly tilapia and catfish. Studies by the NaFAA has identified a number of strengths in the enabling environment that is conducive to aquaculture development:

- Abundant and perennial availability of water
- High prevalence of lateritic soils, which have a compact texture with a water retentive capacity crucial for pond construction
- Topography dominated by flat land and plateaus which provides ease for pond construction
- Steady supply of animal waste ideal for pond fertilization, from a large number of household livestock farmers
- Satisfactory habitation density
- Local consumer preference for aquaculture products over other forms of protein

While there is some local knowledge on pond construction and managements, inputs have not been able to advance beyond leaves, grass or other on-farm supplies. There is also limited feed supply, farming technology, and facility capacity of hatcheries. As a result, aquaculture production in the country has remained low.

Transport

Globally, one-third of reported catch is wasted along the fishery value chain. In Liberia, losses in the quantity and quality of fishery products is caused by a lack of infrastructure, onboard and onshore ice supply, and poor post-harvest practices. Many fishing communities in the country do not have proper road access to markets, which results in product spoilage during the extensive transportation period. Even if the quantity of the catch is maintained, investing simply in measures to preserve catches onboard and along the value chain can reduce post-harvest spoilage and increase the value of fish products.

Market Price Information

Fish is generally sold by retail by the piece, with sizes of 250 grams and higher found in the marketplace. Larger fish are preferred by do not necessarily sell for higher price per kilogram.

Regulatory Enforcement

As a part of the WARFP, Liberia strengthened the artisanal fishing sector through the establishment of the inshore exclusive zone (IEZ), registration of small-scale fishing fleets, tightened and increased transparency surrounding fishing licensing policies. Liberia also introduced the use of a satellite-based vessel monitoring system (VMS) for industrial fleets and increased sea patrols to curb illegal fishing, and officially recognized the rights to community fisheries management in the Robertsport area. A WARFP survey found that communities have since achieved better social, economic, and ecological outcomes as measured by the Fisheries Performance Indicators (FPIs).

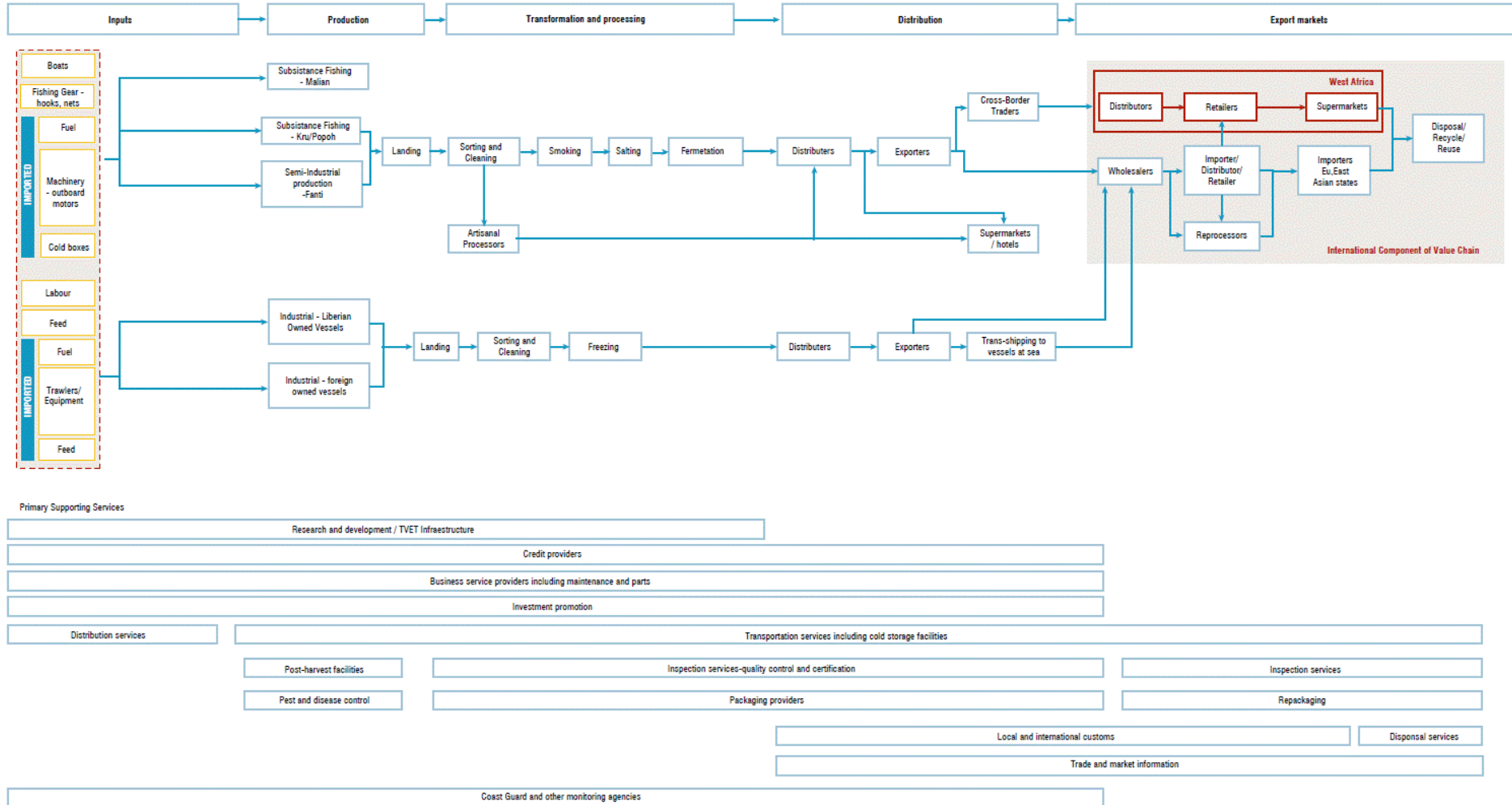


Fishery & Aquaculture Sector SWOT Analysis

Strengths	Weaknesses	Opportunities	Threats
<ul style="list-style-type: none"> • Abundant water resources, high irrigation potential and appropriate climate and topology for tilapia and catfish breeding • Preferential access to several lucrative markets including EU (EBA) and USA (AGOA) • Existing infrastructure including over 900 ponds and 3 hatcheries • Initiatives by Government and donors to rebuild the sector including rehabilitation of ponds and hatcheries 	<ul style="list-style-type: none"> • High fish storage / processing costs due to limited availability of grid electricity • Poor transport and limited cold-chain facilities • Shortage of quality inputs for aquaculture including feed and fingerlings • Lack of comprehensive fisheries and aquaculture policy • No capacity to certify and quality-approve fish • Shortage of aquaculture veterinarians / professionals 	<ul style="list-style-type: none"> • High demand for fish from both local and regional markets • Potential to invest in different aquaculture farms including freshwater ponds, integrated fish farming, brackish water and mariculture • Potential for investment in inputs and processing sectors within aquaculture supply chain • Little to no competition 	<ul style="list-style-type: none"> • Competition on the domestic market with imported fish due to incentives to import rather than catch/farm locally

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Figures and Tables Fishery & Aquaculture Value Chain



Source: Republic of Liberia National Export Strategy