

Value Chain Analysis of Captured Shrimp and Tilapia from Keta Lagoon in Ghana

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Authors' contributions

This work was carried out in collaboration between all authors. Author HA designed the study, reviewed literature and wrote the first draft of the manuscript. Authors HA, DY, SQ, AP and JEE undertook data collection and analysis of the results. Author HA undertook discussion of findings and the final write-up. Authors HA, AP and JEE edited the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Aims: The study examines the value chain analysis of captured shrimp and tilapia from Keta Lagoon in Ghana.

Study Design: The research employs cross sectional study design including simple random sampling and stratification of the sample frame. The sample frame for the research include: fishermen, agents, traders and fish processors.

Place and Duration of Study: Data was sampled from seven major fishing communities: Anloga Lashibi, Fiahor, Kedzikope, Tegbi, Kordzi, Deta and Woe along the Lagoon between November 2014 and February 2015.

Methodology: Data was collected with designed semi-structured questionnaires on socio-economic characteristics, costs & benefits, marketing channel of shrimp and tilapia and challenges

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in fishing. A total of 70 canoe owners, 14 agents, 35 traders and 35 processors were sampled.

Results: Economic analysis of shrimp and tilapia fishing shows that both total investment cost and revenue for shrimp was higher than tilapia. The price per kilogramme of the former was higher than the later. Return on investment for Shrimp and tilapia were 1.05 and 1.10 respectively. Shrimp fishermen made US\$2.9 margin more than those of tilapia. Also, retailers of shrimp made US\$4.2 more margin than the retailers of tilapia. The sector is faced with decline in fish stock, sizes, catch and pollution of the lagoon environment among others.

Conclusion and Recommendations: The lagoon fishing is profitable because the fishermen employed few fishing inputs. Shrimp is more profitable than tilapia. Within the value chain of both fish species, retailers made the highest margin with the least being the fishermen. The price per kilogram of shrimp was far higher than that of tilapia because is high value fish species. It is recommended that there should be implementation of close seasons to enhance fish growth and recovery of fish stock to boost catch thereby improving income of actors within the value chain. There is the need to also regulate the sector.

Keywords: Shrimps (*Penaeus duorarum* & *Parapenaeopsis atlantica*); Tilapia (*S. melanotheron* & *T. guineensis*); value chain; Keta Lagoon; Ghana.

1. INTRODUCTION

Coastal lagoons are environments suitable for human activities. The lagoons form important vulnerable ecosystems, housing a wide variety of fish, shrimps, crabs, mollusk and polychaete species [1]. [2,3] identified 50 lagoons of all sizes along the 536 km long coastline of Ghana one of which is the Keta Lagoon (Anlo-Keta lagoon). [4] estimated a total lagoon area for Keta in Ghana to be 330km². The lagoons are subject to artisanal fishery, providing 5% of the total inland catch. They have been traditionally managed in the past to sustain fishery levels [3] but in recent decades this management has been non-functional in many lagoons including the Keta lagoon [5]. In numerous cases, lagoon fisheries are open-access, without regulations on restrictions on fishing effort [2,3].

Keta lagoon is the most extensive brackish waterbody in Ghana, which has also been designated as a Wetland of International importance (Ramsar site). It is separated from the Atlantic Ocean by a large sandbar, the Keta sand spit. The lagoon supports artisanal fisheries that comprise significant proportions of economic and dietary resources of the human populations clustered around the lagoons. The lagoon fishing serves an important source of income for people in the communities living around it [6]. It is of utmost importance as it serves as nursery grounds for fin fish and shell-fish, which often sustain significant fisheries. Some of the juvenile marine species including Clupeidae, Mugilidae, Lutjanidae, Peneidae, Carangidae, Sciaenidae and Pomadasytidae can be found in the Lagoon [6,7]. Lack of job opportunities has pushed many

people from the communities surrounding the lagoon into fishing for a living, resulting in intense fishing pressure [6].

A total of 18 fish species belonging to 13 families were identified by [7], in a study conducted on the status of fish diversity and fisheries of the Keta Lagoon in Ghana. They found four of the species namely: the cichlids (*Tilapia guineensis* and *Sarotherodon melanotheron*), the Bonga shad, (*Ethmalosa fimbriata*) and the blue-swimming crab, (*Callinectes amnicola*) to be commercially important in the study area. The most important shell fish found by [7] in the lagoon was the blue swimming crab (*Callinectes amnicola*). The Keta lagoon is fished intensively using traditional canoes. The most occurred fishing gears used on the lagoon were the brush parks (Acadja) (29.1%) and basket traps (23.2%), whilst the least occurred gear was the encircling net (1.8%). There is the deployment of multiple fishing gears which was highly pronounce at Anloga where fishing appeared to be a daily source of income. Fisheries in the Keta lagoon are threatened from irresponsible fishing and environmental degradation [7].

1.1 Literature Review

1.1.1 The Volta delta

Keta lagoon has a mean depth of 80cm and a maximum depth of 2 m. The mean pH and salinity for the lagoon are 8.33 ± 0.28 and $14.55 \pm 5.18\%$ respectively with mean Secchi depths of 0.53 ± 0.19 m. Water temperature average 28.99°C . The mean dissolve oxygen is 4.20 ± 0.73 mg/l [6,8].

The construction of the dams on the Volta at Akosombo and Kpong has affected the ecology of the Lagoon leading to lower water levels and increased salinities as seasonal floods in the lagoon delta have virtually ceased. The only discharge are those associated with the generation of electricity. Prior to the construction of the dam at Akosombo, Keta Lagoon was the most principal source of non-marine fish and, although diminished in importance, it still supplies a substantial proportion of the inland catch [8]. Current total catch is unknown.

1.1.2 Socioeconomic activities in the Keta municipality

The indigenous people within the municipality are the Anlos in the South, the Tongus and Avenors in the North. Fishing (both marine and lagoon), salt wining and vegetable farming are the main occupations of the people in the south, while those in the northern sectors are mainly farmers with some fresh water fishing in the areas along the rivers and channel. The southern part is famous for its shallots and produces large quantities of onion and okro. Other crops grown include pepper, tomatoes, cassava and maize. Lagoon fisheries is a major source of livelihood for many people in the area. The species caught are mainly tilapias which are sold locally and as far as Accra. Salt mining is a substantial industry, particularly during the drier periods of the year. Mangrove exploitation for fuelwood is another important source of income in the area [9].

A socio-economic survey undertaken in 1998, in the Keta Municipality by Shenker et al. [10] indicated that about 88% of the people sampled were engaged in fishing as a primary occupation. Eight (8%) percent and four (4%) percent were found to be engaged in farming and trading respectively as a primary occupation. The eight percent engaged in farming are especially in the Anloga and Woe area where shallot and vegetable farming was a major component of their daily activities. Most (70.3%) of the respondents at Keta also had secondary occupations to supplement their income. The remaining 29.7% earned their living solely by fishing. Low catch and the tendency of the lagoon to dry out during protracted dry seasons were the reasons given for considering a secondary occupation. Although mat weaving (11.1%), salt collection (3.7%) and other occupations were engaged by others, farming

(33.3%) was the most common secondary occupation, according to the results of the survey [6].

A number of studies have been undertaken on the lagoon including Fisheries of Two Tropical Lagoons in Ghana, West Africa [6], the Status of Fish Diversity and Fisheries of the Keta Lagoon, Ghana, West Africa (11), the Hydrology and Fisheries of the Lagoons and Estuaries of Ghana [2], Conservation of Coastal Lagoons in Ghana-the Traditional Approach, Landsacpe and Urban Planning [11], Traditional Management of Some Lagoons of the Gulf of Guinea (Ivory Coast, Ghana, Togo, Benin) [3], Technical Assistance and Investment Framework for Cultured-Based Fisheries in Ghana [4] and a Directory of African Wetlands [8]. However, no study has been undertaken in the area of value chain analysis of shrimp and tilapia therefore calling for this work. The study therefore explore summary of the value chain and marketing channel of shrimp and tilapia, market margins, investment cost, revenue, income and return on investment. Final conclusion will be drawn from the findings.

1.1.3 Value chain analysis

A value chain can be defined as the full range of activities which are required to bring a product or service from conception, through the different phases of production (involving a combination of physical transformation and the input of various producer services), delivery to final customers, and final disposal after use [12]. The chain actors, who transact a particular product such as crustaceans and fish (shrimp and Tilapia) as it moves through the chain in the fishing industry includes fishermen, traders (marketing), processors and final consumers. One of the reasons of value chain analysis is due to growing division of labour and the global dispersion of the production of components, systematic competitiveness [12]. [13] in a study of value chain of fish and fishery products indicated that value chains for capture and culture fisheries differ within regions. Value chain describes a high-level model of how fishery businesses receive raw materials as input (capture and culture fisheries), add value to the raw materials through various processes and sell finished products to customers. Moreover, fishery value chain can be defined as interlinked value adding activities that convert inputs into outputs which, in turn, add to the bottom line and help to create competitive advantage. A value chain typically

consists of inbound distribution or logistics, manufacturing operations, outbound distribution or logistics, marketing and selling, and after-sales service [13].

This paper therefore examines the value chain and marketing channel of captured shrimps and tilapia from the Keta Lagoon in Ghana. Knowledge about the structure, functions and distribution of profit, margins along the value chains and challenges provide information to policy makers about potential opportunities for improving the gains.

2. METHODOLOGY

2.1 Study Area

Kata Municipality lies within Longitudes 0.30°E and 1.05°E and Latitudes 5.45°N and 6.005°N. It is located to the east of the Volta estuary, about 160km from Accra. It shares common borders with Akatsi South District to the north, Ketu North and South District to the east, South Tongu District to the west and the Gulf of Guinea to the south. The total surface area of the Municipality is 753.1 km². The largest of the water bodies in the Municipality is the Keta Lagoon, which is also the largest lagoon in Ghana. The water body facilitate water transportation which is cheaper than road transport, and has potential for fishing [14].

Keta lagoon has an open water surface of 27,000ha and measures 27 km in length and 15km in maximum width. The mouth of the Volta is 750m wide. The total area of 182,000ha, save of the lagoon, is flooded seasonally, but permanent swampland exists in a number of localities throughout the delta [8].

2.2 Sampling and Data Collection

The following were the target groups sampled for the survey; 70 fishermen, 14 agents, 35 traders and 35 processors. Ten (10) fishermen, 2 agents, 5 traders and 5 processors were interviewed from each of the 7 communities.

The sampling frame for the research included the following: fishermen, agents, traders and fish processors within the value using semi-structured questionnaires. Questionnaires were

designed and pre-tested, reviewed and finalized for the data collection. Data was collected at the selected landing sites around the Lagoon namely: Anloga Lashibi, Fiahor, Kedzikope, Tegbi, Kordzi, Deta and Woe (Fig. 1). Anloga is the main fish landing site around the lagoon and it is close to a major market centre. This landing site is a converging point for a good number of the canoes which bring fish to the major market (Anloga market). Data for the study was collected between November 2014 and February 2015, and was analyzed using SPSS (V.20).

The chief fisherman from Anloga landing site of the Lagoon and some opinion leaders from the 7 communities assisted in identifying the target groups. The study employed cross-sectional study design. In this type of study, either the entire population or a subset thereof is selected, from these individuals, data are collected to help answer research questions of interest. Simple random sampling method was also employed for the study in addition to stratifying the sampling frame. The various questionnaires designed were categorized into socio-economic characteristics, business operations and constraints.

2.3 Formulas

- Profit

$$\text{Profit } (P) = \text{Revenue } (R) - \text{Total Cost} (TC)$$

- Margins

$$\text{Profit margin} = \text{Revenue} - \text{Variable Cost}$$

- BCR

o The Benefit-Cost Ratio (BCR) is the monetary benefits of the programme divided by the cost [15].

$$BCR$$

$$= \frac{\text{Programme Benefits}}{\text{Programme Costs}}$$

- Return on investment (ROI) [15]

$$ROI =$$

$$\left(\frac{\text{Net Programme Benefits}}{\text{Programme Costs}} \right) \times 100$$



Fig. 1. Shows the areas around the Lagoon where the study was undertaken

Fig. 1. Study area

3. RESULTS AND DISCUSSION

3.1 Socio-economic Characteristics

3.1.1 Gender

Out of the 70 fishers sampled in the study, about 91 percent were males. It attest to the fact that most people involved in fishing were males but there is this practice whereby females buy canoes and fishing gears for most of the men for fishing. This confirms the notion that capture fisheries is male dominated with high occupational health hazards as well as safety issues. Most of the fishermen (95%) involved in tilapia sold their catches at the landing sites. All the processors sampled were females. Also, all the traders in the tilapia trading (except at the landing sites) were females while 10% of men engaged in shrimp trading as agents. Ninety percent (90%) of the agents interviewed were females.

3.1.2 Educational level

In terms of highest education attainment, 48% and 21% of the fishermen had attained the middle school/JSS and basic level respectively while 20.6% had not had any formal education. Furthermore, 10.3% had attained SHS/Secondary level. Also, sixty five percent (65%) of traders and 52% of processors had not had any formal education while the highest

educational level attained was senior high. There is an important link between people's education and literacy, and their ability to engage in processes, the co-management of fish stocks and other aquatic resources, and in processes of livelihoods diversification [16,17]. A UNESCO Global Report on education suggest that areas with high concentrations of illiterate people are also home to many of the worlds' fisherfolk [18].

3.1.3 Tribe

The result of the analysis indicated that all the respondents sampled were Ewes and are indigenes.

3.1.4 Membership of an association

The role of an association plays an important role in the value chain. The role of the collective action organization in a value chain depends on the activities it conducts. The organization can be linked to a value chain both vertically (buyer-seller relationships) and horizontally (inter-firm coordination, linkages to services providers and to policy makers) [19]. Results from the study shows that all the fishermen sampled during the survey were not members of any cooperative fishers associations. They were rather members of welfare associations involved in community organized programmes such as funerals and festivals among others. It implies that the fishermen individually market their fish produce

hence have no collective action in bargaining or negotiation as well as access to market information.

3.1.5 Experience

This was measured as number of years in fishing. Experiences of the fishermen ranges from 2 to 60 years with an average of 26 years. A good number of the fishermen had been fishing for 15 years (18.6%) followed by 30 years (17.1%).

3.1.6 Type of fishing gears and fish caught

The types of fishing methods/gears used on the lagoon include, nets (cast, set), basket traps, bottles, hook and lines, "tekali" (rope), bamboo, "hatsi" and "atidza". Atidza is an aggregating device which provide artificial shelter for fish thereby enhancing fish breeding in the lagoon. The making of Atidza involved the use of mangrove and twigs cut from vegetation [20]. Palm branches are also used in the development of the atidza environment. Fishers find it difficult to access the palm branches which can be accessed from distant communities at a higher cost. One of the illegal practice is the use of small mesh size nets (less than 50mm). Also, some fishermen use atidza (acadja) without the permission of the appropriate authority as indicated in the Fisheries Regulation 2010; L.I 1968. Some of the species caught in the lagoon are crab, tilapia, shrimps, grey mullet, Mojara, ten-pounder, (red snapper-not common) and shad among others. Fishes especially tilapia are also caught by hands when the water level of the lagoon becomes very low or dried up at some areas.

3.1.7 Number of crew

The number of crew going fishing in a canoe ranges from 1 to 3 people with 1 being the modal figure. This is so because the average length of canoes ranges between 3 m to 16 m. About 65.5% of the canoe owners' sampled said only one person occupies the canoe during fishing expedition. In addition, 29.3% and 5.2% indicated that their canoes are occupied with 2 crew and 3 crew respectively.

3.1.8 Rental of gears

Findings from the study shows that canoes and nets could be rented for fishing at Deta, Kodzi and Fihor. Renting of canoes ranges from US\$1.25 to US\$2.5 while that of the net is about

US\$3.75 per trip. There are some fishermen who do not own gears hence had to rent them for fishing expeditions. The fishermen also provide fish (in-kind) when returning the hired/rented canoes and nets.

3.1.9 Occupation

The sampled fishers were also engaged in fish processing (women), crop farming [10], animal rearing and non-fishing trading.

3.1.10 Finance in the Shrimp and Tilapia value chain

Table 1 shows that fishers depend mainly on own capital (50%) followed by loans and credit from family members, friends, credit associations and agents (43%). The credit provided by the agents in the form of fishing gears (for shrimp harvesting) is paid back in installments. The fishing gears (e.g. canoe) revert to the fisherman after full payment. The agents who provide the fishing gears buy the shrimp at an agreed price. Furthermore, the fishermen, after full payment of the cost of the fishing gears, decide to sell the fish to the persons they so wish but consider the financier of the business as well.

Table 1. Source of funding of fishing business

Source	Frequency (%)
Own Capital (Own savings)	35 (50%)
Loans from friends/agents/ relations /susu/credit union, agents	30 (42.9%)
Gift/inherited from parents/ relations to start business	10 (12.9%)
Formal loans (micro-credit scheme or bank)	2 (2.9%)

3.2 Value Chain Analysis of Tilapia and Shrimp

3.2.1 Processing

3.2.1.1 Icing of shrimps and tilapia

3.2.1.1.1 Shrimp

None of the fishermen interviewed carried ice to shrimp fishing. They sometimes put fish on ice at the landing site when they come back from fishing expedition as they wait for their customers. Icing is mostly done by the women (agents/wholesalers) who buy the shrimp. According to the women, the quality of the shrimp is affected when it is not iced leading to

either rejection by the market (retailers) and or decrease in price.

3.2.1.1.2 Tilapia

According to the fishermen, traders who come from afar to buy the tilapia, put them on ice before transporting them to their respective destinations. This is to prevent them from going bad. However, traders from the nearby communities send it away without icing for immediate processing.

3.2.1.2 *De-heading and descaling of shrimp and tilapia*

Agents/wholesalers tend to descale, de-head and devein the shrimps and store them in freezers until there is demand for them. This normally happens when there is glut in the market. According to them, glut of shrimp in the market sometimes delay payment from the retailers and also decrease the price. Sometimes the traders (retailers) also advice the agents/wholesalers to store them and sell them when the demand increase in the market. Tilapia is not de-headed but sometimes de-scale before it is sold.

3.2.1.3 Degutting

Some women traders position themselves at the landing sites, buy tilapia in cash or on credit, degut and descale before selling to the general public. Some also undertake that activity upon request and charge a fee depending on the quantity while also processing the guts into fish oil.

3.2.1.4 Packaging

Shrimp is transferred from plastic containers of different types and sizes in the canoe into the containers brought in by the buyers, iced and then sent away. The agents pack their shrimp in either plastic bowls, aluminum bowls or baskets, among others. Tilapia catch is mostly poured directly into the canoes during fishing. The buyers held them in either plastic bowls, aluminum bowls or basket for transportation to the market centers.

3.2.2 Supply chain of shrimp and tilapia

3.2.2.1 Shrimp

3.2.2.1.1 Fishermen

The fishermen go fishing at various times of the day. Some set traps in the evening and go to

collect their catch the following morning or, stay with the trap in the evening till the following morning to avoid pilfering. Some take off to fishing between 4 pm and 6 pm and then arrive between 6.30 am and 9 am the following day. The fishermen stay between 2 hours and 15 hours on the lagoon. An average of 9 hours is spent on the fishing ground. The long period is due to the fact that they must protect the trap from poachers. The longer hours also suggest the decline in fish stock. The fishermen report on poor catch as well as decline in sizes in recent times. Shrimp caught is mostly held in plastic containers in the canoe before landing. Catches of shrimp can either be sold on the lagoon (canoe to canoes transaction), at home or at the landing sites. Some fishermen who double as agent sometimes sell directly to the retailers in the market. The catch is always weighed before it is sold. The cost ranges between US\$3.00 to US\$4.00 depending on the season. Shrimp is sold whole (i.e. not de-headed, descaled and devein) at the landing sites (Fig. 2).

3.2.2.1.2 Agent/Wholesalers

These are people involved as middle men/women in the value chain. They serve as the linkage between the fishermen and mainly the retailers. Some of the fishermen perform dual role as fishermen and also as commissioned agents. They, in addition to fishing, buy from other fishermen and then sell to retailers. The agents seek the services of people to procure the shrimp either on the lagoon and or at the landing site. The needs of such people are taken care of by the agents. Some of the agents have their own canoes to collect and aggregate the catch of shrimp on the lagoon. There is an agent who paid the educational expenses of the person assisting her. Some of the fishing gear (canoes and nets) are bought by the agents for the fishermen to pay in installments. There is an informal contract between the fisherman and the agent that enable such fishermen to always sell to them at slightly reduced price or same price until they pay off the cost of the canoes and nets/traps. The agreement provides continuous supply of shrimp to the agent. The fisherman must seek the permission of the agent who bought the canoe for them before selling the shrimp to another customer when they have not defrayed the total cost of the canoe. The agents also provides some items in kind such as food and provision to the fishers when they go fishing. Shrimp is either sold within the country and or across the border to Togo (Fig. 2).

3.2.2.1.3 Retailers

The retailers sell shrimp to the consumers at various markets in and outside the municipality. Most of the retailers are mostly located at the Tema (European Market), Denu (a border town) in Ghana and Togo (Fig. 2). Shrimp is mostly sold to middle and higher income brackets in these markets. Restaurants (mostly Chinese restaurants in Ghana) also patronize the shrimp. The price of 1kg of shrimp ranges between US\$12.5 – US\$15.00.

3.2.2.1.4 Consumers

The consumers are mostly middle and higher income households who buy shrimp for home consumption (Fig. 2).

3.2.2.1.5 Transportation

Transportation also play a key role in the shrimp value chain. The agents and the wholesalers use commercial vehicle going to the markets to sell their shrimps. For those who sell their shrimps in Tema in the Greater Region which is the main market, portions of their transportation costs are borne by the retailers. The retailer bear between 10%-30% of their total transportation cost.

3.2.2.2 Tilapia

3.2.2.2.1 Fishermen

There are fishermen specialized in the harvesting of tilapia from the lagoon. The fishermen go as early as 4 pm to set their nets/traps and wait for a maximum period of 9 hours to harvest and return. Due to pilfering of trapped fish, the fishermen wait for long hours before coming home (Fig. 2). Bottle traps are also set mainly by the women who come early in the morning to pick them. Sticks are used to identify the location of the bottles in the Lagoon. The fishers do not go to fishing with ice. After landing the fish, they call their clients to buy the fish or wait for other customers to come and buy. Fish is sold to processors, wholesalers, retailers and consumers. The women involved in fishing either sell their catches outright or process it. The fishermen are not able to store the fish properly since there are no cold chain facility at the landing sites. Sometimes the fish is exposed to the sun for long hours leading to deterioration in quality.

3.2.2.2.2 Wholesalers

Wholesalers buy fish (mainly processed) and transport them to other markets. There are

wholesalers who buy and put the fish on ice at the landing sites before transporting them to their respective destinations. Some also sell the fish to processors which is not a common situation.

3.2.2.2.3 Processors

The study indicated that most of the fish landed is sold to fish processors (80%) who fried and sun dried. Eighty-five percent of the fish sold to fish processors are fried. The fried and sun dried fish are transported to other districts in and outside the region for sale. Some fried fish are also sent to Togo (a neighboring country) for sales.

3.2.2.2.4 Retailers

Some of the traders buy the tilapia fresh (from fishermen and wholesalers) or processed (from processors) and then sell in smaller quantities at particular market or sell on the streets (hawking). There are those who descale and de-gut before selling. Some undertake such activities upon request of the consumer.

3.2.2.2.5 Market

Tilapia markets are located within the community, in the district, other districts, other regions and across border (Togo).

3.2.2.2.6 Transportation

Fish is transported by commercial vehicles ("taxis or trotros"). None of these is transported using private vehicles unless it is bought by a private person.

3.2.3 Profitability and Marketing margins

Table 2 summarizes the economics of shrimp and tilapia fishing from the Keta Lagoon. The investment cost included depreciated cost of canoe, paddle, nets, traps, and ice chest. In all, total cost for harvested shrimp (US\$166.75) is higher than tilapia (US\$151.25). A kilogram of shrimp sold at about US\$4.00 as compared to Tilapia which sold at about US\$0.75.

Results suggest that the total average net income accrued from shrimp catch for a fisherman in a year was US\$709.25 as compared to tilapia which was US\$693.25. Return on investment for shrimp and tilapia are 1.05 and 1.10 respectively.

Table 3 summarizes the margins made on kilogram of shrimp and tilapia marketing.

Fishermen made an average margin of US\$3.45 for a kilogram of shrimp sold. Also, agents made US\$0.8 more margin on a kilogram of shrimp sold as compared to the fishermen. Retailers made the highest margin of about US\$2.20 more per kilogram compared to the agent. In all, the retailers made US\$3.00 per kilogram margin as compared to what the fisherman made.

Table 2. Economic analysis of shrimp and tilapia fishing

	Shrimp	Tilapia
Investment cost (Depreciated) (US\$)	59.75	56.25
Variable cost (Excluding maintenance cost) (US\$)	36.00	19.43
Maintenance cost (US\$)	72.00	75.58
Total cost (US\$)	166.75	151.25
Revenue (US\$)	876.00	844.50
• Ave. Qty (kg)	219	1,126
• Ave. Price/kg(US\$)	4.00	0.75
Net Income (US\$)	709.25	693.25
Return on investment (%)	105	110

Exchanged rate: 1US\$ = GH₵4.00

An average margin of US\$0.55 is also made on the sale of a kilogram of tilapia by the fishermen. The wholesalers of processed tilapia made an average of US\$0.45 more margin per kilogram on tilapia compared to the fishermen. Processors of tilapia made an average margin of US\$0.63 more per kilogram compared to the wholesalers of processed tilapia while retailers of processed fish made an average of US\$0.63 more margin than the processors. It implies that retailers of processed tilapia made a margin of US\$1.70 more margin than the fishermen.

Table 3. Margins (GHS)

	Shrimp (US\$/kg)	Tilapia (US\$/kg)
Fishermen	3.45	0.55
Agents/Wholesalers	4.25	N/a
Wholesalers (Processed)	N/a	1.00
Processors	N/a	1.63
Retailer	6.45	2.25

3.3 Challenges

The following were some of the challenges encountered by the fishermen in fishing:

- i. Pilfering of trapped fish species (in net and basket traps) on the lagoon;
- ii. High cost of materials for the preparation of basket traps and atizda (Acadja);
- iii. Difficulty in accessing materials for the preparation of basket traps and brush parks (e.g. atizda/Acadja);
- iv. Decline in fish catch;
- v. Decline in fish sizes;
- vi. Destruction of fishing traps;
- vii. Competition from influx of more fishermen;
- viii. Use of illegal fishing net e.g. smaller mesh sizes (less than 50mm);
- ix. Depletion of mangroves around the lagoon;
- x. Drought;
- xi. Frequent breakages of bottles (as trap) for fishing; and
- xii. Pollution of the lagoon and its environment.

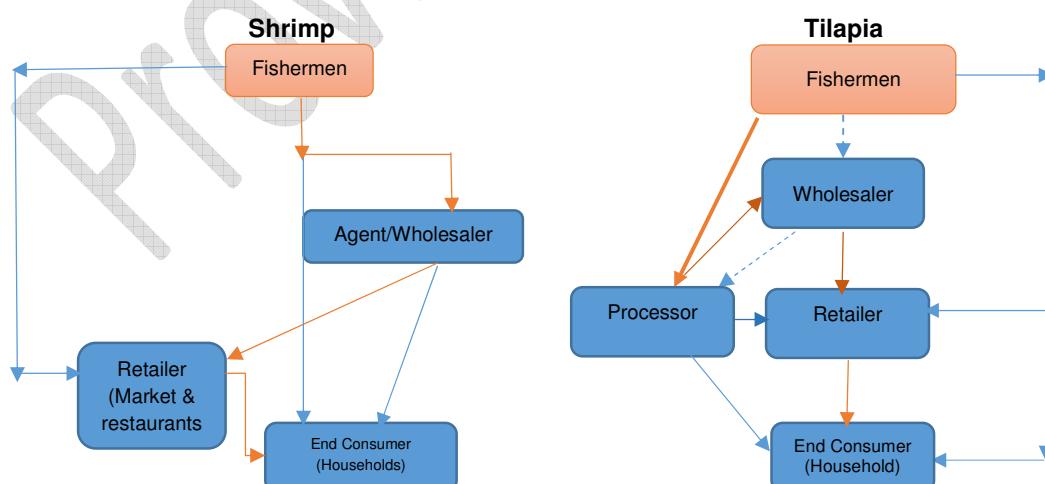


Fig. 2. Supply chain of shrimp and tilapia
The pink colour of the chain shows the main supply chain of fish species

4. CONCLUSION AND RECOMMENDATIONS

Keta lagoon is the most extensive brackish water-body in Ghana, which has also been designated as a Ramsar site. The lagoon supports artisanal fisheries that comprise significant proportions of economic and dietary resources of the human populations clustered around the lagoon. The Lagoon fishing serves an important source of income for people in the communities living around. Limited job opportunities has pushed many people from the communities surrounding the lagoon into fishing for a living, resulting in intense fishing pressure leading to decline in fish stock. There is also limited land available for crop farming which could be a substitute for fishing [6].

It is more profitable to go into shrimp fishing business than tilapia. An average amount of US\$3.45/kg is made by a shrimp fisherman as compared to that of a tilapia fisherman who made US\$0.55/kg. Also, results showed that an average price of tilapia is far lower (US\$0.75/kg) than that of shrimp (US\$4.00/kg). Fishers of Shrimp made US\$2.9 more than those involved in tilapia. Also, retailers of shrimps made US\$4.2 more than those of tilapia. Return on investment shows that both business are viable. Among the actors along the value chains, retailers reported the highest margins with the least being the fishermen. Comparing the margin made by shrimp and tilapia fishermen, the former records the highest compared to the latter mainly due to high selling price. The major market for shrimp is well-developed targeting mostly middle and upper income group as compared to the tilapia which target mostly lower and middle income. The sector is faced with declining in fish stocks hence affecting fishing activities, revenue and income of the actors within the chain.

Some of the challenges faced by the fishermen are decline in fish catch and sizes, pollution of the water body, drought and pilfering of fish on the lagoon. In addition is the use of illegal fishing nets and mangrove exploitation. Furthermore, fishers find it difficult accessing materials for the building of brush parks (atidza) and basket traps.

It is recommended that the Municipal and District Assemblies collaborate with the regulatory bodies in the management of the lagoon resources and canoes. There should be closed seasons to enhance fish growth in the lagoon including shrimp and tilapia, the restoration of

mangrove along the banks of the water body and clean environment. The fishers should be prevented from and/ or punished when they use unorthodox method in fishing. Fishermen associations should be formed to help in managing the resources and take care of the welfare of its members. Community base Fisheries Committee along each landing site should be formed in each community to regulate the sector. The fishers should be introduced to alternative and/ or additional livelihood to reduce fishing pressure on the lagoon. Fishers should also be sensitized on fish handling (during fishing expedition and after landing).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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