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Cover photo: Salted fish on a drying platform at Elmina (Credit SNV)

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ACRONYMS

ABS	Albert Bosomtwi-Sam Fishing Harbor
CSIR	Center for Scientific Industrial Research
FAO	Food and Agricultural Organization
GDP	Gross Domestic Product
GSS	Ghana Statistical Service
SFMP	Sustainable Fisheries Management Project
SHS	Senior High School
SNV	Netherlands Development Organization
UNDP	United Nations Development Program
USAID	United States Agency for International Development

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INTRODUCTION

The USAID/Ghana funded Sustainable Fisheries Management Project aims at ending overfishing of key stocks important to local food security through a multi-pronged approach:

- Improved legal enabling conditions for co-management, use rights and effort-reduction strategies
- Strengthened information systems and science informed decision-making
- Increased constituencies that provide the political and public support needed to rebuild fish stocks
- Implementation of applied management initiatives for several targeted fisheries ecosystems

The project seeks to improve the livelihoods of more than 100,000 men and women involved in the fishery industry including the post-harvest sector.

The fisheries sector plays an important socio-economic role in Ghana. The fishing industry in Ghana supports the livelihoods of about 10% of the population. The importance of the fishing industry stems from significant contribution of around 60% of the national protein supply and around \$87 million exports in 2009. Fish and sea food account for 16% of total household spending on food (GSS, 2008). The marine sub-sector is by far the most important source of local fish production, delivering more than 80% of total supply. These fish products amount to about 12% of exports, earning 4% of GDP. This does not include post-harvest activities such as the marketing of fish, artisanal and industrial processing, and local catches. The sector also provides direct and indirect employment to about 130,000 people and is the major occupation for communities living along both the coastline and fresh water sources. Fishing is male dominated whereas women's roles are focused on the preservation and marketing of fish.

In the fisheries sector, small pelagic landings make up about 83% of the total catch by weight, and are an important source of animal protein contributing to food security and livelihoods. Women control postharvest processing in Ghana and along the West African shores; however, they often do not take full advantage of the many opportunities that these markets provide. In addition, traditional methods of smoking and drying do not produce the highest net value of fish product.

In this report the SFMP is synthesizing knowledge on post-harvest livelihoods to better understand the scope and opportunities available for scaling up. The objective of this report is therefore to:

- Identify and understand the various livelihood options on fish post-harvest value chain along the coast of Ghana.
- Determine the financial viability of the different livelihood options
- Identify the various barriers associated with these options
- Recommend options for scaling up under the project

METHODOLOGY

This report is based on a number of other post-harvest related reports. It seeks to collate and synthesize all the reports into one document so as to provide information on the various livelihoods identified in post-harvest fisheries amongst coastal dwellers.

The source reports used for this study are as follows:

- Entee S. (2015); Process Characterization and Needs Assessment Report.
- Darpaah G, Samey B. (2014); Post-harvest Loss Study.
- Fisheries Commission (2015); Fish Handling and Preservation.
- Fisheries Commission (2015); Post-harvest Losses.
- Improved Fish Smoking; Ghana (Chapter 3) UNDP
<http://tcdc2.undp.org/GSSDAcademy/SIE/Docs/Vol5/improved.pdf>
- Essuman, K.M. Fermented fish in Africa. A study on processing, marketing and consumption. FAO Fisheries Technical Paper. No. 329. Rome, FAO. 1992. 80p.
- Nerquaye-Tetteh G., Eyeson K.K., Tete-Marmon J. 1978; Studies on Bomone, a Ghanaian fermented fish product. Food Research Institute of CSIR.

Additional data was collected through a case study of the Central and Western region Fish Processors Improvement Association (CEWEFIA). Fifteen (15) fish processors made up of 5 fish smokers, 5 momone makers and 5 fish fryers were interviewed using structured questionnaires. Furthermore, a process characterization for both the frying and salting process was carried out to buttress the information gathered in the field and from the source reports.

PROCESS CHARACTERISATION

According to the Department of Marine Resources (2002), fish processing means the application of preservative means and/or methods to the flesh of fish to maintain quality and prevent deterioration; and includes but is not limited to preparation, supply, storage, refrigeration, or transportation of unprocessed fish. This can also be termed as the fish processing value chain; “from net to plate”.

Fish processing is dominated by women along the Coast and Volta basin. Where men get involved in the processing they are perceived as helping their spouses. Like their male fishermen counterparts, the educational levels of women processors are generally low and few go beyond Senior High School level. Most inherited the business from their parents while others operate with their mothers or aunties.

The Fisheries Commission of Ghana provides a local context to fish processing, indicating the following steps:

- Fishing is the first step in the processing chain. Fishing methods have an effect on quality. The quality of the finished product depends on the quality of raw fish. Thus it is essential to keep lines and nets in the water for as short a time as possible. Also seining and trawling times should be short.
- Handle fish gently. Fish should be picked by holding the head in order to avoid bruising and gaping of the flesh.
- It is important not to damage fish during harvesting because damaged skin reduces marketability of the product. It also creates a path for micro-organism transfer from skin to flesh thereby accelerating spoilage.
- Store fish in clean containers on board the fishing vessel. Maintain hygiene on board and provide a clean fishing environment.
- The need to ensure optimum conditions and cause the least possible stress to live fish during transportation.
- If no transport is available, caught and stunned fish should be chilled to 0-5oC. Place fish in between 3-5cm thick layers of ice chips.
- Use insulated boxes to maintain the cold chain by preventing ice from melting too quickly. The rule is to use 1kg of ice for 1kg of fish.

- Do not make too many layers of iced fish in boxes, this could result in bruised flesh. The best is always small crushed ice.

Stunning is the process of killing the fish, if not already dead; after which the fish is bled. This should be done under hygienic conditions.

Gutting: After stunning and bleeding the fish it is gutted. This involves opening up the fish at one side and removing the intestines and other unwanted inner parts and excess blood. This should be done under running water and on a corrosion resistant table.

Descaling: This follows gutting and involves the removal of scales, fins, head and tail depending on the species of fish and final objective of processing. Descaling can be done using a rough surface on the fish or using knife; or automated or hand held descaler.

Cleaning: Clean or wash fish under running water. This is to prevent micro-organism contamination. The continual re-use of water should be avoided.

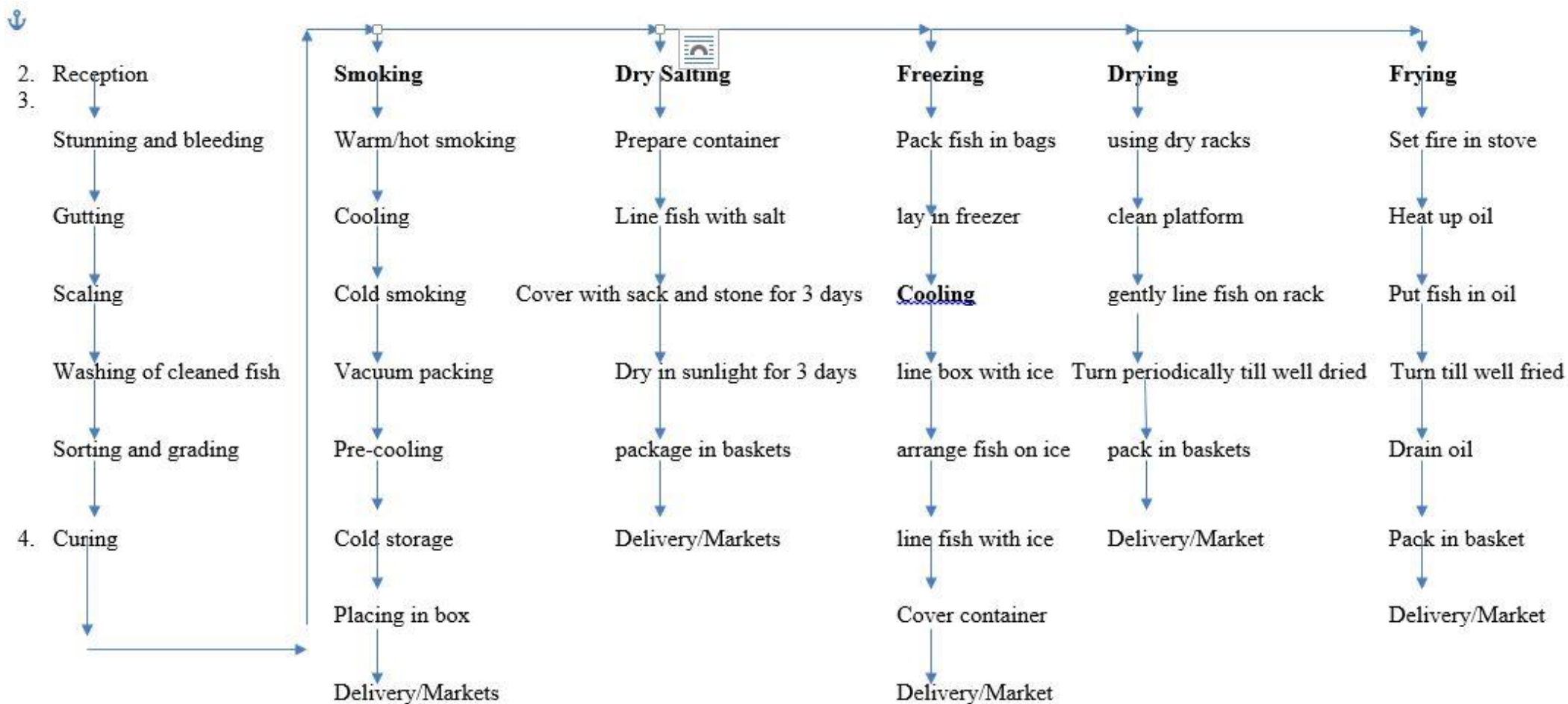
Sorting and grading: This is the practice of separating the fish into groups with different physical properties e.g. size, species and color. It also involves separating fish by quality according to certain pre-determined criteria. Containers such as tumblers are used during this process; in addition sizing devices and scales may also be used.

Slicing to steaks or cut to preferred sizes: Depending on fish species, size and degree of processing, fish are cut, sliced to steaks, filleted and deboned (where necessary).

Curing: Cured fish refers to fish which has been cured by subjecting it to fermentation, pickling, smoking, or some combination of these, before it is eaten. These food preservation processes can include salting, smoking and flavoring the fish, or cooking.

Curing methods are also preservative methods entailed in fish processing. The above listed processes are further represented in Figure 1.

Figure 1: Fish Processing Methods



Fish Smoking

Process

Fish smoking is the most important method of fish preservation in Ghana. About 85% of Ghana's fish is smoked. Fresh fish directly landed at the shore and frozen fish from cold stores are usually smoked for consumption. Fish processors usually prefer to smoke fresh fish instead of frozen fish because it is perceived as having a better taste, texture and appearance. Fish processors from the Volta Region barely smoke frozen fish and so are reliant on freshly landed fish. Consequently, less fish is smoked during the lean season.

A general observation in the Western, Central and Volta Regions was that most processors work from their homes, via adjoining kitchens/processing areas. There were a number of fish smoking sites that were identified at New Takoradi, Elmina (Anlo Beach) and Shama. Most processors are more comfortable working by themselves than in cooperative groups, however the majority had helpers; either their children, family members or local casual workers.

According to a report by the UNDP on Improved Fish Processing (2001), the art of fish smoking, said to be as old as civilization, combines three main processes:

- Cooking - since the smoking is done at temperatures above 80°C, the flesh of the fish is cooked while the heat destroys bacteria on and inside the fish; and enzymes in the gut and flesh are de-activated;
- Drying - the fire which produces the smoke also generates heat, which dries the fish;
- Smoking - the smoke is produced by burning wood containing a number of compounds, some of which kill bacteria; the process has a preservative value.

Depending on the type of fish to be smoked, its uses and storage time, the smoking process in Ghana can take the form of 'wet hot - soft smoking' or 'dry hot - dry smoking'. Both processes are carried out at temperatures high enough to cook the fish.

Fish smoking is done at the artisanal level by women in coastal towns and villages and in areas along rivers and the shores of Lake Volta. In most fishing communities, the main economic activity of women is fish processing and marketing. The reasons for smoking fish are varied and in Ghana, the process has proved relevant to:

- Prolonging shelf life
- Enhancing flavor and increasing utilization in soups and sauces
- Reducing waste at times of bumper catches through storage for the lean season
- Increasing protein availability to people throughout the year

Fish smoking entails a number of activities as outlined below:

1. Acquiring fish from landing site or cold store
2. Defrosting frozen fish
3. Washing and sorting fish
4. Arranging fish on trays to allow water to drain
5. Lighting fire in the fish smoking stove
6. Arranging trays on stove
7. The drying/heating process
8. The soft smoking process
9. The hard smoking process
10. Making fish easier to pack, transport and market.

Despite the fact that modern methods of fish preservation, such as freezing and refrigeration, are available to some extent, the demand still persists in Ghana for the traditional flavor, taste and color obtained by smoking.

Before the introduction of the Chorkor smoker in Ghana in 1969, four main types of traditional smoking ovens were used. These were: the cylindrical/round mud oven, sometimes referred to as the Fanti oven; the cylindrical metal/oil-drum oven; the rectangular mud oven; and the rectangular/square metal oven. Adjetey and Altona ovens were introduced to Ghana in 1962 and 1971 respectively; the Ivory Coast oven was later introduced from Cote d'Ivoire. None were particularly appropriate for the purposes of smoke drying, which requires a sequence of intense heat to cook the fish followed by a long period of drying over a low fire.



Figure 2 'Saiko' fish



Figure 3 Fresh fish from the landing site

Acquiring fish from landing site or cold store: Landed fish are bought by fish processors either from the Konkohemaa, the wife of the fisherman or the fisherman himself. In years past, the women experienced difficulties sustaining fresh fish prices, as the fishermen chose to sell at different prices at will. This was difficult for the women so they came together and selected a leader, whom they call the Konkohemaa. Her main responsibility was to bargain fish prices on behalf of the processors. This price is maintained for at least two weeks before another negotiation is made.

In the lean season, most processors especially in the Central region buy fish from the Chinese trawlers (or their local agents). According to the natives of Elmina, the Chinese after harvesting fish dispose of the smaller sized fishes. Over time, they started selling it to the locals and the fish come in frozen rectangular slabs and are known as 'Saiko'. The fish type varies from *Ebue*, to herrings etc.

Large scale processors use vehicles to transport the fish to their processing sites, while some pay others to carry the fish or they do it themselves.

De-frosting frozen fish: Many fish smokers do not usually want to smoke frozen fish. Those who do are mostly large scale processors who work continuously throughout the year without wholly depending on landed fish from the sea. Some prefer to travel to Tema harbor to purchase the fish in large quantities instead of purchasing from their local communities.

Frozen fish are left in the sun to defrost. At times water is poured on the fish to speed up the defrosting process. The processors separate the fish once it starts to thaw and arrange them directly on the trays or in a large pan. Often fish processors do not wash frozen fish, explaining that the heat from the fire will kill all the microbes. However others wash the fish and even degut them before smoking.

Washing and sorting fish: The fish is washed in large pans/containers and directly arranged on the smoking trays to drain. This process then entails descaling the fish, if needed, and sorting broken fish from intact ones. Seaweed, shrimp and baby crabs are also removed. On few occasions, some processors degut the fish but this is not a common practice. Fish is handled with care to reduce breakage as it depreciates the value of the final product.

Arranging fish on trays: This process involves arranging fish on the trays after washing. The tray is a component of the most common fish smoking stove in Ghana, the Chorkor smoker. In any tray fish are arranged in line with each row offset by a half-length, with the direction changing by 90 degrees relative to the tray below. This is to ensure that every part of the fish receives even heating. The trays allow for easy draining of water from the fish before it is put on the stove. Some processors do this directly over the fire, especially where they do not have enough space. Many others drain the water first before laying the trays over the fire.

Lighting the fire: The fuel wood is lit in the combustion chamber of the Chorkor stove. The communities visited use varying types of wood, usually forest offcuts, wood from farmlands and mangrove wood. Mangrove wood is usually used in parts of the Western region; Axim towards half Assini, and Anlo Beach at Elmina. Other communities such as Winneba, Apam, and Takoradi use forest offcuts and wood from farmlands. The Takoradi communities also use a lot of rubber wood too. They use wood pieces, cement paper, palm fruit, coconut husk or various fiber in addition to kerosene to light the fire.

In the Central region, a number of processors light their stoves with embers from a coal pot (charcoal stove). They similarly employ the use of rubber, pieces of wood and other fibers to light the fire and keep it burning.

Arrangement trays on fire: The trays are then arranged on top of each other over the fire chamber. Depending on the quantity of fish available, people can pile up to 20 trays on one stove. This depends more on the number of workers available as they prefer to pile all the fish on the stove at a time and interchange periodically instead of smoking in batches, as the fish could go bad if left unsmoked.





Figure 4: Arranging fish on a Chorkor tray



Figure 5: Lighting a fish smoking stove

The drying and cooking process: Fish smoking entails cooking, drying and smoking process. The drying period is where the fish are introduced to high heat levels which remove the water, blood and oil from the fish. During this period the trays are left uncovered to allow hot air and smoke to flow through the trays, to heat and then cook the fish. During this period, depending on the number of trays stacked, they are interchanged at least once to allow for even drying and cooking of the fish.

The cooking stage requires heat and not smoke, hence the firewood arrangement is done in such a way that the wood burns well in order to generate heat and not excessive smoke. The control of heat intensity is done by experience. The fuelwood is pushed further into the combustion chamber if the intensity of heat needs to be increased or vice-versa when the heat needs to be reduced.

Some processors do not push lit firewood to the center or back of the combustion area which, as a result of their experience, prevents oil and water from dripping directly unto the fire. If this does happen, thick black smoke is formed which affects the texture and color of cooked fish and makes it look as if it has been steamed, with a firm flesh and golden brown leathery skin. This process is usually attributed to medium to large and oily fish. Small pelagics, such as *Sardinella* and mackerel go through a much shorter drying process or are smoked directly. For instance the anchovies are sundried before smoking. The cooking times vary according to the type, size and quantity of fish and the state of fuelwood (moisture content) and type of smoking stove being used.

Soft smoking process: There are two types of smoking processes, soft and dry. The main difference is the degree of dryness that the processor seeks to achieve, and is mostly driven by how long the processor wants to store the fish. Soft smoking usually takes about 1-3 hours depending on the quantity and size of fish; and yields a moist, versatile product with about 40-55% moisture content but with limited shelf life of 1-3 days (UNDP, 2012). This therefore takes a shorter period than the hard smoking process.

The processors usually induce smoke by using sugar cane husk, coconut husk, palm fruit or even rice husk. Some processors dip the fibers in water and put them directly on the fire causing high levels of smoke. The top tray is covered with plywood to keep most of the smoke within the tray set. Apart from inducing smoke, the processors also use certain wood types, such as mangroves, during this period to give a reddish color to the fish.

Some processors, apart from interchanging trays, also turn each fish on the tray to ensure even cooking. This is done carefully, usually when the fish is almost ready and well dried to allow for easy turning and to avoid breakages. Others also wait till the fish cools a little then they cover with an empty tray and turn over. After this activity, the fish is left to dry for a short time over a low fire. Soft smoked fish will last for at most one week.

Dry smoking process: Dry smoking, which is usually preceded by soft-smoking, takes about 10-18 hours or sometimes days over a low fire to allow the fish to dry well, yielding fish with a 10-15% moisture content, sometimes even below 10 percent. Fish smoked by this process have a shelf life of 6-9 months when stored properly. Smoke drying is by far the most common method as it allows the product to be stored for months, to be sold when the market offers better prices; and also transported over long distances to national and regional markets.

The small pelagics and herrings are mostly processed this way, because they dry better and can be stored for longer periods, between 6 to 9 months. The fish is periodically smoked during the storage period to prevent mold formation or bacterial infestation and is also smoked before being taken to market.

Salted fish smoking: A Fisheries Commission document on post-harvest fish loss, presents another form of smoking fish. This process involves curing the fresh fish in a brine solution for about 12-16 hours. The fish should be turned over at least 2 to 3 times during this period after which it is arranged on trays and air dried before it is smoked.



Figure 6 Arranging fish on the tray of a Morrison stove



Figure 7 Fish smoking in process



Figure 8 Arranging trays

Cooling and packaging: After the fish is well smoked, it is left to cool on the trays until the wood burns out. After cooling, some women pack the fish in a cross cutting manner and leave them in the tray until they are ready for the market. Fish are usually packed in baskets of varied sizes with larger fish at the base and smaller ones on top. The baskets are mostly lined with cement paper or brown paper. The fish are counted and gently packed on each other until the basket is full and sometimes beyond the height of the basket but within the length of the cement paper. The package is then bagged within a netted rope sack which is tied at the top. Others place a large jute sack in a pan, pack the fish in brown paper and arrange within the sack. After it has reached the desired height, they wrap the sack together with the pan with nets and tie at the top with a stick.



Figure 9 Drying process with a plywood cover



Figure 10 Packaging



Figure 11 Storage in trays



Figure 12 Cooling Process

Storage

Smoked fish storage varies across regions. Some processors pack the fish in baskets or metal pans lined with cement paper or brown paper. The whole package is bagged in heavy rope made of nets. The package is usually placed on a raised platform in a cool room. Others bag the package in large plastic sacks before placing them on raised platforms or mats. The packages are then left within the compound of their homes. Some processors apply insecticide around the base of the raised platform to prevent infestation. Depending on the type of fish, storage could be for weeks or as long as 9 months. Few women keep their fish in dry and well-ventilated rooms; and under healthy conditions, which would negate the need for insecticides. To reduce insect and mold infestation, the processors heat up the fish periodically during the storage period.



Figure 13 Packed for transport



Figure 14 Storage in Trays

Transportation

Across the Central and Western regions, transportation of fish to markets is done by individuals or groups of processors. The baskets of fish are loaded onto trucks or vans and the baskets are packed close to each other to ensure that none falls during the journey. Sometimes the processors accompany the vehicles but can also follow later, while their agents at the destination receive the fish and sell on behalf of the processor at an agreed price. In smaller communities transport is arranged on group basis; and during the bumper season when volumes are larger, processors may arrange individual transport.



Figure 15 Packaged for the market



Figure 16 Packaged for the market

Markets

Depending on the quantity smoked, the fish is either sold within the community or nearby; or sent to larger markets. Drawing information from the Post-harvest loss document (Dapaah, 2015), the following are some major markets for smoked fish traders: Twifo Praso, Agona Nkwanta, Fumso, Elubo, Jeways Warf, Tikobo No. 1, Sefwi Bekwai, Bibiani, Bogoso and Tarkwa in the Western Region, Agbogbloshie, Mamprobi, and Kasoa in the Greater Accra Region; and Mankessim in the Central Region. The Albert Bosomtwi-Sam (ABS) fishing harbor at Sekondi is one of the largest fish marketing centers for both fresh and processed fish in the Western Region. Other marketing centers include Techiman, Joaboso, Kumasi, Sehwi-Wiawso, Kintampo, Bolgatanga, Denu, Asankragua and Aflao. These are major

market centers where processed and fresh fish are sold in large quantities. Some women only trade in fish but do not process, thus some of the fish processors sell in bulk to such traders and therefore do not undertake direct retail. Others directly retail their fish by themselves.

Market days vary throughout the week, and usually fish processors can spend up to a week at the market centers, making sure all their fish are sold and all or most of their money is collected before they return home. Where there is an excess of fish at the market, some processors are compelled to sell at low prices in order to clear stock and return home. They also sell at low prices when they think the fish may go bad if left unsold.

Inputs

The process of fish smoking involves the following inputs:

1. Fish smoking stove
2. Fuelwood
3. Fish
4. Mats, baskets, cement or brown paper, pans and knives
5. Labor

The fish smoking stove:

Before the introduction of the Chorkor stove in the late 1960s, fish smoking ovens were the cylindrical (round) mud type, sometimes referred to as the Fanti oven; the cylindrical metal or oil-drum oven; the rectangular mud oven or the rectangular/square metal oven. These stoves had a single layer for smoking the fish, thus productivity was very low. The ovens had low capacity, were fuel inefficient and could not cope with the large volumes of fresh fish landed during bumper fish seasons, contributing to high post-harvest losses. Subsequently, FAO and the Food Research Institute of the Council for Scientific and Industrial Research (CSIR) in Ghana designed and introduced the Chorkor smoker. The Chorkor smoker was cheap to make, easy to use, with large capacity, low firewood consumption, shorter smoking times and produced high-quality smoked fish. However, they were not portable, an advantage that the cylindrical stoves had over the Chorkor.

The Chorkor stove is predominantly used in Ghana, most fish processors kept their cylindrical stoves and use them for storing and periodically heating the fish. The Chorkor stove comprises of a base, either made of mud, brick or blocks, and trays made of wood and wire mesh. It was observed that most processors preferred the mud base stove because it was far less expensive even though most of them were poorly maintained. A few had plastered their stoves with cement and others had used cement block instead of mud. This was identified mostly in the Ewe communities in the regions as they seem to pay particular attention to the good maintenance of their mud base stoves.

Fuelwood: Fuelwood is the main energy source for smoking fish. Various kinds of wood used depending on the geographical area are Neem, Acacia, red and white mangroves, cocoa trees, bamboo, orange trees and even rubber trees. The women mostly buy the wood from local wood sellers or trucks from neighboring communities. The fuelwood input is about 6% of the production cost of smoked fish.

Fish: All types of fish can be smoked. For a day's production cost, fish is the largest input component at 80%. According to the Market Segmentation study carried out (Amaning, 2016), the predominant types of fish stock processed by fish processors were *Sardinella* (93%) and Anchovy (72%). Other types of fish stock processed include Barracuda (54%), Tuna (46%), Horse Mackerel (31%), Red Fish (31%), Shark (4%) and Shrimps (1%). The regional dynamics were slightly different as the predominant types of fish stock processed in

the Central Region was *Sardinella* and Anchovy whereas that of the Western Region was *Sardinella* and Barracuda.

Labor: The processors are mostly supported by their husbands, children and other family members. Some also employ helpers depending on the load of work available. Payment is either in cash or kind. On average, helpers who are paid for their service receive GHs 10.00 for each batch of smoking carried out. Labor, packaging, transport and other expenses account for about 14% of the production cost.

Table 1: Stock of fish processed

Fish Stock Processed	Number	Percent
Central Region	(N=100)	
Barracuda	42	42%
Tuna	49	49%
<i>Sardinella</i>	98	98%
Horse Mackerel	34	34%
Red Fish	30	30%
Anchovy	79	79%
Shrimps	1	1%
Western Region	(N=60)	
Barracuda	45	75%
Tuna	25	42%
<i>Sardinella</i>	50	83%
Horse Mackerel	16	27%
Red Fish	20	33%
Anchovy	36	60%
Shark	7	12%
Overall	(N=160)	
Barracuda	87	54%
Tuna	74	46%
<i>Sardinella</i>	148	93%
Horse Mackerel	50	31%
Red Fish	50	31%
Anchovy	115	72%
Shrimps	1	1%
Shark	7	4%

Source: (Amaning, 2016)

Financial Analysis

According to Kwarteng (2014), the operational expenditure that goes into fish smoking business includes cost of fresh fish, market fee, cost of packaging, transportation, fuelwood and labor as shown in Table 2 and Figure 17 below. In taking the measurements of the inputs involved, a weighing scale, basket and bucket were used to ascertain the amount and weight of fish processed. This figure is compared with the final weight of the processed fish, taking into consideration the weight of the items used in packaging. The data presented below is from a limited test in the Volta Region, however fuelwood and fish prices will vary considerably by region and further field assessments are needed to better understand broader production costs.

Table 2: Financial Analysis of Fish Smoking production costs

Expenditure per kg smoked fish	Cost per kg (GHs)
Cost of fuelwood	161
Average cost of fresh fish	1883
Cost of packaging smoked fish	29
Cost of transporting smoked fish	51
Labor	58
Agent/market fee	15
Sales cost of smoked fish	2583
Profit	386

Source: (Avega, 2016)

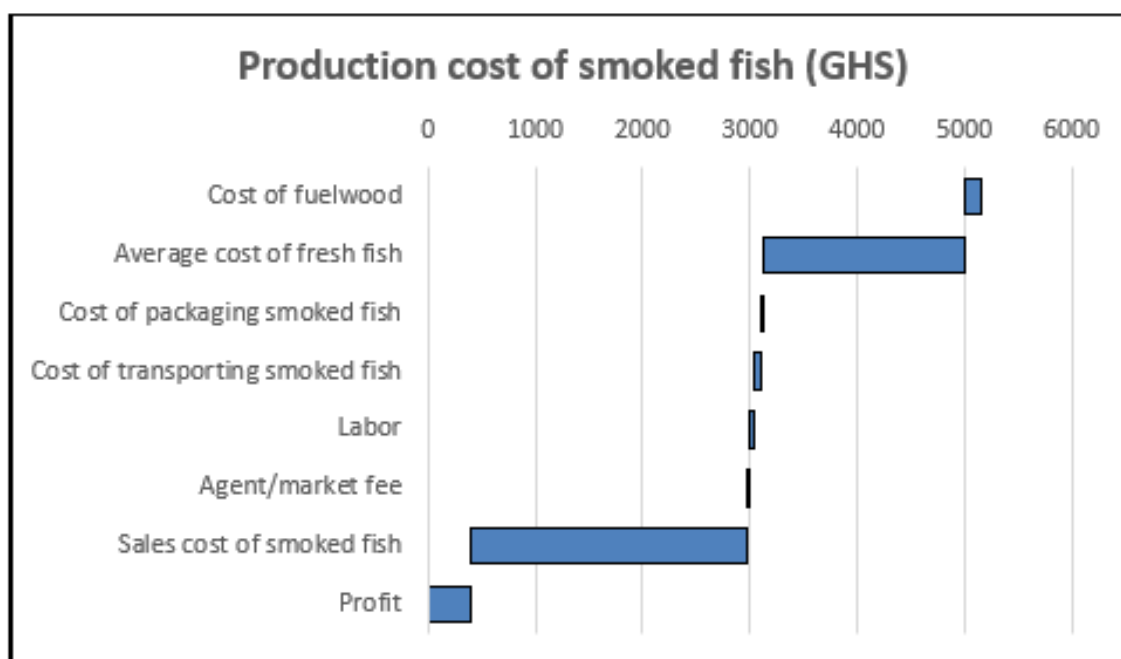


Figure 17: Production Cost in fish smoking

Fish Salting and Fermentation

The act of processing food and meat with salt is one of the oldest means of food processing and preservation. It involves the addition of salt (Sodium chloride) at a very high concentration to preserve the fish or prevent it from decaying. Salt compounds serve as inhibitory agents to microbes such as bacteria, fungi and other disease-causing agents that cannot survive in high salinity environment or medium.

The underlying principle of salting is known as osmosis. Salt creates osmotic pressure when added to fish by removing water molecules from the fish as well as microbes, which may be present. Fish are placed in a strong solution of salt which is stronger than present in the fish

tissue. Water then is removed from the fish tissue into the brine until the strength of the two solutions is equal.

Fish salting is however different from fermentation, which involves microbial activity that is allowed for a limited number of days before salt is added to halt or limit microbial activity. In some cases, salt is not added before the fermented fish is dried.

Two methods of salting, wet and dry salting are carried out in the Central and Western Regions. In both cases, preliminary preparations are done by washing and degutting fish (i.e. the intestines and head contents of big sized fish are removed and washed with sea-water, lagoon and any other source of water available).

Fish mostly used for salting in Ghana are Tuna, bonito, shark, ray, octopus, snail, sole, seabream, catfish, croaker, skate, triggerfish and mullet. Of these 70% is sourced through artisanal fishery, 20% through industrial fisheries and 10% from cold stores (FAO, 2016).

Process Overview

Several types of salt have been used for food and meat processing over the years. For fish processing in Ghana, there are two main types of salt commonly used.

Pure common salt is sodium chloride (NaCl) which has gone through industrial processes, purification and production. Commercial salt on the other hand, contains varying levels of impurities depending on the source and method of production. In Ghana, almost all common salts are iodized and salting of fish is primarily done with commercial salt.

Commercial salt can be further classified into three main groups depending on the source and the method of manufacture:

- Solar salt - prepared by the evaporation of sea or salt lake waters by the action of sun and wind. Major centers of production are therefore found in tropical or sub-tropical countries.
- Brine evaporated salts - underground salt deposits are brought to the surface in solution (a brine) and this is evaporated, usually by heating.
- Rock salt - natural deposits of salt are ground to varying degrees of fineness without any purification.

The suitability of salt for any particular application depends upon several factors, the most important of which are: chemical composition; microbiological purity; and physical properties.



Figure 18: Bags of salt used for fish processing

Several factors which influence the rate of salt absorption and water replacement in fish are:

- The higher the fat content, the slower the salt uptake;
- The thicker the fish, the slower the penetration of salt to the center;
- The fresher the fish, the more slowly salt will be absorbed;
- The higher the temperature, the more rapid the salt uptake.

During subsequent drying the presence of salt has the following effects:

- The higher the salt concentration the greater the replacement of water, and therefore the less water that remains to be removed during drying; thus making drying faster.
- The higher the salt concentration, the less water that needs to be removed to produce a satisfactorily preserved product;
- Salt tends to absorb moisture from the air at relative humidity of more than about 75 per cent during the drying process. During subsequent storage, fish will not dry further; but may even absorb more moisture (TDRI).

Fish Salting in Ghana

Fish salting in Ghana is dominated by women along the coastal regions and the Volta Basin area of the country. The main types of salted fish in Ghana are Momone, Kako, Koobi and Ewurefua (triggerfish), made from particular types of fish as stated below:

(a) Momone: Momone is a Ghanaian – Akan name for salted, fermented and/or sun-dried fish locally produced and used for flavoring soups and stews (Nerquaye-Tetteh *et al.*, 1978). Various species of fish such as catfish, barracuda, seabream, threadfin, croaker, grouper, bonito, mackerel, herrings, squid, octopus, bumper, snapper, and ribbon fish can also be used. Larger species of fish (e.g. shark) may be cut into smaller pieces or split dorsally. The dressed fish is thoroughly washed with sea, lagoon or fresh water. The raw fish is either left overnight before salting or dry-salted immediately after washing.

Salting and fermentation lasts for one to six days after which the fish is dried on the ground, nets, stones or raised platforms for one to three days. This is a soft product with a very strong pungent and sometimes offensive smell. It is susceptible to larvae infestation (maggots), mold growth and bacterial spoilage especially if the salt level is too low. It can be stored for at least two to three months.

Some women after acquiring the fish, descale (if needed) and then wash the fish to remove any dirt. They then degut the fish and apply the salt on all surfaces of the fish. They arrange the fish in a well-like structure built with cement which they call the ‘wall’, cover with a sack, and put large heavy stones on it. Others also cover with the smoking tray before placing the sack and stones on it. The fish are arranged in such a way that they lie on their backs, to allow the salt to seep into the fish properly. In the Central region, there are a group of fish salters who are called the ‘ahyensum’ meaning ‘putting in water’. These processors usually process medium to large size fish. These fish can be stored in the brine solution for as long as two years until there’s a ready market. They pack the fish into big yellow buckets and transport to the market. The fish are usually not dried before taken to the local market. However when the fish are being transported to another country, they are washed and dried for easy transportation. It is important that the salt used for this type of salting is clean from all impurities.

The processors salt the fish in different ways. Whereas some spread salt on the fish layer after layer, others stir the mixture i.e. the fish and salt with a stick to form an even mixture. Others also put the salt and fish in a plastic bucket, cover it and shake it to get an even mixture. After a day some water collects in the ‘wall’ as a result of the reaction between the salt and water in

the fish. They then remove the fish from the brine solution with a plastic sieve and wash twice with clean water before drying on raised platforms made from bamboo and covered with heavy nets. Within the day they turn the fish about three times to ensure even drying and then cover with big black polyethylene bags at night to prevent rain or dew from wetting the fish.



Figure 19 Preparing fish for salting

(b) Kako and Koobi: Shark, skates, ray (kako) and tilapia (koobi). The raw fish is dressed and thoroughly washed. Dry salt is rubbed into the gills, the belly cavity and on the surface. It is then arranged in alternate layers with salt and allowed to ferment for two to three days before being dried for two to four days. More salt may be sprinkled on the fish during drying. These including Ewule/Ewurefua are dried products with a mild to strong odor. They are susceptible to fragmentation, insect infestation and mold growth. For long term storage (four to six months) they have to be re-dried periodically in order to maintain quality.

(c) Ewurefua: Triggerfish. The fish may or may not be scaled, gutted and have the gills removed. The fish is gutted by making a slit from the belly to the lower jaw. It is then washed and transferred into brining tanks containing a small quantity of saturated brine from previous salting or from sea water. Dry salt is poured over the fish and stirred into the brine to ensure even distribution and contact with the fish. The tank is then covered with jute sacks or polythene sheets, weighed down with stones or a wooden board and allowed to ferment for 12 to 24 hours. After fermentation, the fish is removed and sundried for two to three days, either on the ground, grass, nets or raised racks.

Two main methods are employed. These methods are dry salting and wet salting. (Figures 20-22)



Figure 20 Salted fish after being in the 'wall' for a day



Figure 21 Washing the salted fish



Figure 22 Drying on a platform

Dry Salting

In the coastal countries of Côte d'Ivoire, Gambia, Ghana and Senegal, where solar salt produced by the natural evaporation of sea water is readily available and inexpensive, fermented fish is heavily salted (FAO, 2016). In dry salting, the granular salt is applied directly to the fish either in the gills, on the surface or, in the case of split fish, in the belly. The exudate from the fish may be allowed to drain away or be retained. In the latter case, the fish becomes immersed in the exudate and this is often referred to as "pickling" (FAO, 2016). Thus dry salting can be sub grouped into pickle salting and dry salting, where pickled salting entails keeping the salt exudate in the container to immerse the fish wholly in the exudate. This type of salting (pickle) can be used on any kind of fish irrespective of size or species including fatty fish, provided they are submerged in the liquid to prevent oxidation of the fat (rancidity), whereas the dry salting is applied on low fat content fish (fish with white meat) and involves emptying the holding receptacle of the salt exudate (Manu *et al.*, 2016).



Figure 23 Dissecting fish, degutting and washing fish

Pickle Salting

For most Ghanaian women who are into processing of fish by salting, salmon and whales are favored options. Larger fish are scaled and degutted to remove waste and then washed thoroughly mostly with sea water. For smaller Sardinella (size 12 and below), they are simply washed with sea-water and not cut open. Clean basins or large plastic drums, holding receptacles are used and positioned at places where it would not be disturbed during the salting process.

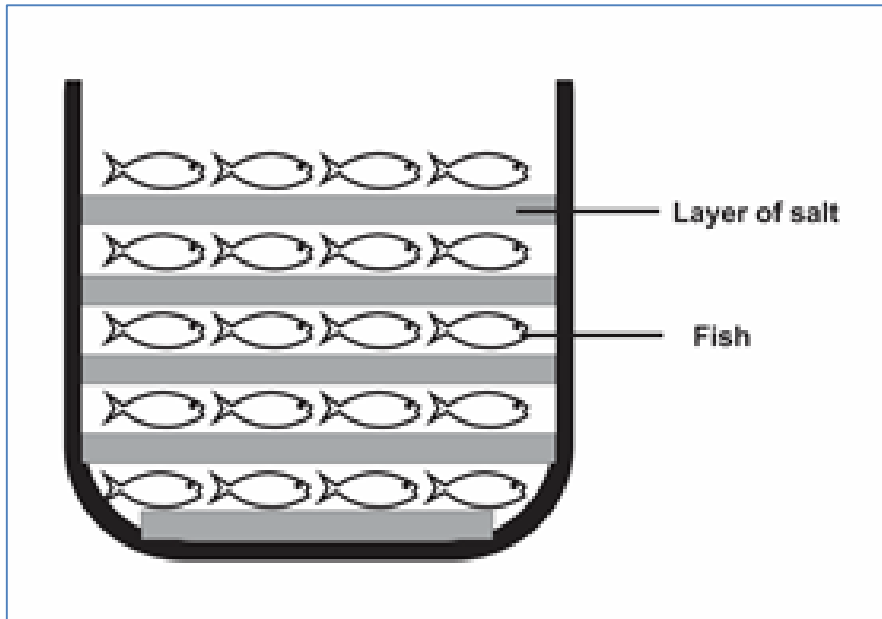


Figure 24: Pickle salting technique

A layer of salt is spread at the bottom of the basin or holding receptacle to about 1.00 cm high. The prepared fish is arranged on top of the salt layer to cover the entire layer. Salt is then spread on top of the arranged fish to cover it entirely about 0.5 cm high. The next layer of fish is arranged on top of the salt layer; this is done repeatedly till all the available fish are arranged layer by layer alternatively with the salt layer. Finally, salt is spread on top of the final layer of fish; cement paper, sack or polythene sheet is used to cover the entire last layer of salt. Heavy stones are placed on top of the pile, to put pressure on the layers of fish to press out water while salt applies osmotic pressure on the fish as well to extract water. By principle, these two activities are to reduce the water activity (A_w) to below 0.86, which prevents microbial growth.



Figure 25 First layer of salt (right)



Figure 26 Arranging fish layers on top of salt layers



Figure 27 Cement paper with heavy stones on top

The covering or sealing of the receptacle creates a hermetic seal, which cuts off oxygen from the entire system. This also initiates a minimal fermentation process, which leads to the development of aromatic flavor of salted fish. The salt exudate soaks up the fish during the process. The quantity of salt used ranged from 2 kg to 8 kg per 18 kg of fresh fish. Salting takes 1-7 days. The salted fermented fish may be sun-dried on tarpaulin or on leaves spread on the ground for 3-8 days depending on climatic conditions (Nerquaye-Tetteh *et al.*, 1978).



Figure 28 Pickle salting technique



Figure 30 Fish covered with sack and stones



Figure 29 Figure 28: Pickle salting technique



Figure 31 Packaging bucket (Pickle salting)

Dry Salting

After descaling, degutting and thoroughly washing the fish, the openings of the fish are filled with salt. Some of the salt is rubbed on the entire body of fish. Care is taken to ensure that the salt covers and fills every part of the fish. The fish are then kept in an air-tight container for 24 hours. Afterwards, the fish are recovered from the holding container and washed using sea water. After thorough washing, the fish are again filled with salt and their bodies rubbed with salt, before being dried on a platform for at least 3 days.



Figure 32: Dry salting process

Wet Salting

In wet salting, the fish are immersed in brine for up to two days or dipped for a few hours. It was observed that some processors who cure fish with brine sometimes reuse the salt solution a number of times. This may be a potential source of bacterial contamination to fresh batches of fish (FAO, 2016). When brine of 30– 40°C is used drying lasts 5-10 days. By this process a dry soft and strongly flavored product is obtained (Nerquaye-Tetteh, 1978).

Important observations on the process:

- It was noticed that almost all the fish processors who produce salted soft fish use cement paper, which is harmful to human health due to the obvious contamination from cement deposits. As a result of the constant education on the adverse effects of cement paper, some processors have resorted to the use of brown paper, and the brown paper used in packaging powdered milk.
- It was observed that the amount of salt used was often arbitrary without any background understanding or measurement as to how much salt is needed for preservation.
- It was noticed that the methods used in commercial production of soft salted fish were unhealthy and inappropriate under national food safety standards
- The use of sea water in washing and cleaning fish and the reuse of water is unhealthy because it increases microbial load on fish.
- The use of bare hands during the salting process can harm the skin of processors over a period of time. When asked how receptive they will be to the introduction of protective clothing specifically gloves, they complained that the brine solution will seep into the

gloves, making the process uncomfortable. Some processors however wash their hands with clean water intermittently to reduce the effect of the salt on their hands. They stated that the pungent smell on their hands is however very difficult to get rid of.

- Although raised platforms have been built by the processors themselves, the salted fish undergoing the drying process are still exposed directly to houseflies and domestic animals, another source of contamination. Some processors also sand dry their fish.
- When the intensity of the sun is not high enough during the 3-day drying period, the fish goes bad and maggots develop.

According to FAO document on gender roles (Essuman, 1992), other major health related issues are:

- There is no effective way of disposing of offals and other waste matter. These are indiscriminately thrown away thus polluting the environment/water body as well as serving as suitable breeding grounds for flies and mites which eventually infest the cured fishery product.
- Solar salt which is predominantly used for curing is often dirty and stored in heaps or in sacks on the bare ground without being covered. Solar salt is a major source of halophilic bacteria which causes poor quality fermented fishery products notably "pink". In Ghana, salt is sometimes reused, particularly in the processing of triggerfish, the brine becomes a source of contamination by osmophilic molds which are noted to cause the kind of spoilage known as dun in salted/fermented fishery products.
- The fermentation tanks used for curing are not usually easy to clean due to their rough surfaces. These containers, therefore, become sites for the growth of microorganisms and sometimes blowfly maggots.

Storage and Markets

Dry pickled salted fish, which is usually the "Momone" is kept in the processing drums or 'walls' for as long as it takes to sell the product. The fish is washed and re-salted periodically during the storage period. This can be stored for about 3 months. The fish is packaged for the market in large pans lined with polythene bags. When all is not sold, the left over is rewashed, salted again and kept in the processing drum until the next market day. Other processors also pack and transport the fish directly from the brine in large yellow rubber buckets (150-200 medium and large size fish per bucket) to markets where it is usually sold to customers in large quantities.

Dry salted fish is packed in baskets lined with cement/milk powder/brown paper tied with a net-like sack to hold the fish in place. The basket loads are kept in a cool room for storage. The dry fish can be stored for up to 6 months during which the fish is redried periodically to avoid spoilage.

Wet salted fish is also dried for at least 3 days. The fish is kept in baskets lined with brown paper, and bagged in a netlike sack. Fish meant for transportation to market centers are packaged the same way and carefully placed against each other in the vehicle so they do not fall over.

Salted fish is a very common product which can be found at Agona Nkwanta, Mankessim, Agboghoshie, Mamprobi, Denu and Aflao markets.



Figure 33 Packaging salted dry fish



Figure 34 Weighing packaged fish

Inputs

Production of salted fish includes the use of a number of resources such as processing drum, drying platform, pans, knives, large polyethylene bags, cutting board, plastic sieves, baskets and netted sacks. Other resources that are always needed during each production cycle are brown paper, fish, salt and labor.

Table 3: Cost of purchasing assets for fish salting

Item	Quantity	Unit Price(GHs)	Total Cost (GHs)
Wall (Cement)	3 bags cement	91.50 (Average)	131.50
	Labor	40.00 (Labor)	(131.50 / 24 = 5.48)
Other Logistics (net, drying platform, big black polyethylene, baskets, pans, plastic sieve, knife, brown paper)			500.00 (Initial purchase and maintenance for a year) (500/24 = 20.83)

The total sum of other logistics is an average cost that takes into account the initial cost of purchase of the items and maintenance for a year. The drying platform is usually made with bamboo, nails and thick ropes to fasten the wood in place. Other types of wood may be used depending on availability and cost. The cost of labor is an average of GHs 5.00 for those who

help with descaling. Head porters who carry the fish to the processing site can also take an average of GHs 5.00. Most women however carry their fish home themselves if in manageable quantities. The cost of transportation to the market vary with distance. Figure 36 below is the average amount from Elmina to Mankesim.



Figure 35: Weighing a bucket of salt

Processors involved in fish salting work for an average number of days. The number of pans processed in a week depends on a number of factors including fish yield and available funds to purchase the fish.

Table 4: Average Processing Period

Item	Number	Quantity
Average working days in a week	5	32 pans
Average number of working weeks in a month	20	92 pans
Average number of working weeks in a year	240	384 pans

Financial Analysis

The details were collected from a process characterization study in Elmina on fish salting. The price of Saiko fish fluctuates depending on the season. When there is a good catch one slab of Saiko fish costs an average of GHS 28 and when the catch is low it costs an average of GHS 55. One large pan of fish usually costs between GHS 150 and GHS 385 depending on the season and the type of fish. The average cost of one bag of salt is GHS 50. Some women however buy the salt in buckets. One bucket of salt weighs 10kg (i.e. excluding the weight of the bucket) and costs an average of GHS 8. An average of 6 margarine buckets of salt fill one 50kg sack. Therefore one margarine bucket of salt will be costed based on the cost of a bag of salt, and by the number of margarine buckets that fill the sack.

Table 5: Inputs in fish salting on a weekly production

Item	Quantity	Unit Cost (GHS)	Total Cost (GHS)
Fish	3 pans (large size)	225	675
Salt	40kg	33	33
Labor	3 people	5	15
Transport	3 pans		28

Item	Quantity	Unit Cost (GHS)	Total Cost (GHS)
Total Expenses			751
Sales	2 basket	750	1500
Profit			749

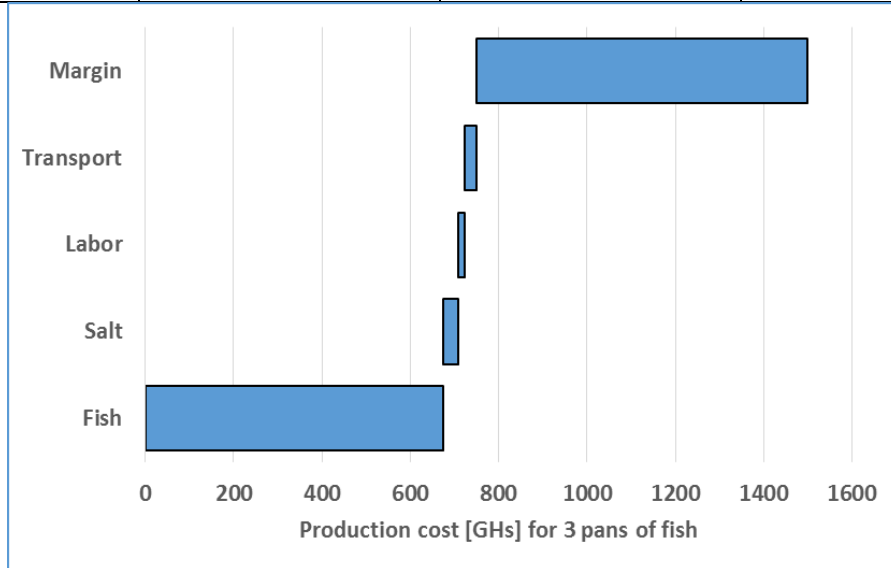


Figure 36: Fish Salting Production Costs

Fish Frying

Frying is a form of fish processing technique that is used to preserve fish for human consumption. In Ghana fish processors who fry fish as their economic activity normally fry fingerlings in very large quantities. Different cultural practices have alternate ways of preparing or dressing fish for frying and in most cases fish is carried home for processing.

Most fish processors who fry in large quantities reside very close to the sea and so fingerlings are thoroughly washed with sea water. For fingerlings with scales, scales are taken off with a knife before cleaning takes place, after which the fish are sprinkled with salt and then spread out on tables to dry for a maximum of 30 minutes before frying. For a well fried fish, the type and size of fish determine cooking time. The fried fish are placed in a basket for the excess oil to drain out. In the Central Region, processors fry all types of fish such as Cassava fish, Ebue, Ntantenble, Sesew, Kokododuo, etc.

Process

From the landing site, processors wash the fish with sea or tap water and then descale them. After the first wash, a second wash is carried out with a considerable amount of salted tap or sea water. This is due to the belief that this gives the fish a better taste than sprinkling salt on the fish directly before frying. The fingerlings are often dried for some hours after washing before being fried. While some workers scale the fish, others light the fire in a small clay fuelwood stove. The oil is then poured in a pan and left to heat up. According to the processors, deep frying is best since it gives the fish a more appealing look.

After frying about four batches, the oil is sieved into another container and the pan is cleaned before the next batch of fish is fried. The residue from the oil is kept and put in the fire periodically to ignite the fire. Once fried, the fish is placed in a sieve to drain the oil before packaging. Some women line the sides and not the base of the basket with brown paper and

then place the whole basket in a plastic bowl. This, according to the processors, is to make the oil drain directly into the bowl and not on the brown paper.



Figure 37 Washing the fish



Figure 39 Frying fish



Figure 38 Frying fish



Figure 40 Packaging process

Inputs

Inputs needed for fish frying are a deep frying pan, salt, oil, firewood, perforated ladle, a cane basket or sieve, and stove. Other fixed inputs are tables, large pans and knives. The predominant stoves used in the fishing communities is the three stone stove. The main source of energy is firewood and types such as Esa, ankyin, begye woba (come for your child), mmabaaba (ladies child), and cocoa may be used. Cassava fish, Sesew, Ebue, Ntantenble, Odoe, red fish, Herrings, Horse Mackerel, and Sukwei are some types of fish usually fried.



Figure 41 Barrel and Gallon for oil



Figure 42 Big cane baskets



Figure 43 Stove for frying



Figure 44 Three-Stone fire



Figure 45 Small cane baskets

Storage

Fried fish is normally stored in baskets lined with brown paper. Some processors after arranging the fish carefully in the brown paper wrap it in a second layer of paper. The baskets with fish are placed in an aluminum pan, and the bundle is wrapped with a large net and fastened at the top with a stick. The fingerlings are poured in a basket lined with brown paper. Another is placed on top and another basket placed over it as a cover. The processors can pack about two more of these baskets on top of the other and wrap with a net and tie with a short stick on top.



Figure 46: Packaging Fried fish

Markets

Fried fish is sold within local communities mostly accompanied with other foods such as kenkey, fried yam and banku. Others also sell the fish alone in the market center in glass display containers; while others hawk theirs on wooden trays. Notable markets are Mankessim and Agona Swedru markets and Dambae and Kade for large scale producers. The fish is usually bagged in polythene fitted in baskets, others also keep the fish in open baskets without using polythene.



Figure 47: Packing of fried fish for the market

Financial Analysis

The information in Table 6 and Figure 8 indicates expenditure in a fish frying business. Depending on the type of fish, the cost of one large pan of fish could cost between GHS 260 to GHS 380 for a pan. As stated in previous Tables, the cost of labor varies depending on how many people are engaged during the process. It costs GHS 10 for labor per pan of fish. In some cases, the processor provides food, shelter etc. for the helper. The average cost of the fish frying stove is GHS 800. On a weekly basis, an average processor can fry about 33 pans depending on availability of fish (

Table 7).

Table 6: Expenses in a fish frying business

Item	Quantity	Unit Cost (GHS)	Total Cost (GHS)
Fish	15 pans	360	5400
Fuelwood	30 bundles	4	120
Salt	1 Olonka	2.5	2.5
Labor	5 people	20	100
Oil	1 drums and a gallons of Frytol oil	280	280
Transportation	15 pans	30	750
Total Expenses			6652.5
Selling Price	15 pans	496	7452.5
Profit Margin			800

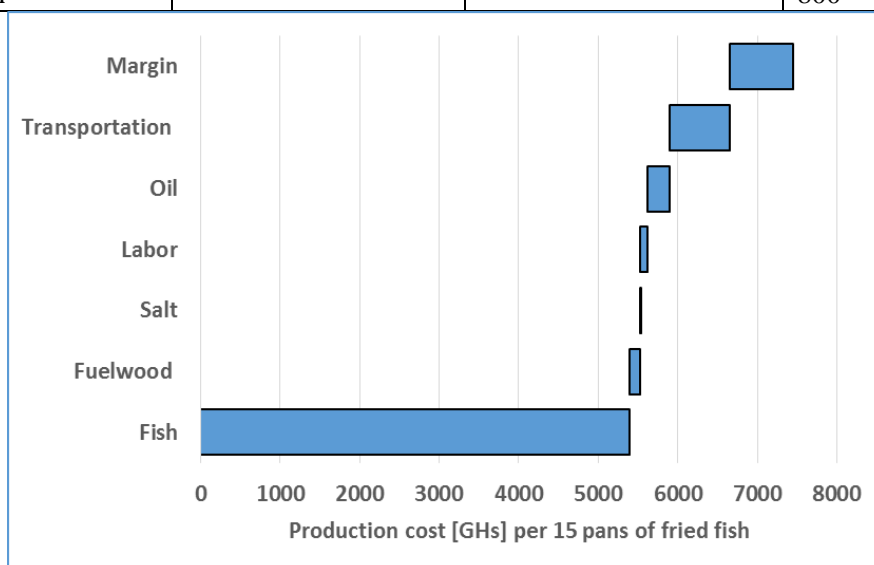


Figure 48: Fish Frying Production Costs

Table 7: Fish frying processing time

Item	Number	Quantity
Average working days in a week	4	33 pans
Average number of working weeks in a month	16	132 pans
Average number of working months in a year	48	396 pans

FINANCIAL COMPARISON

Initial cost of Investment

Data gathered from the field reveals that the investment cost in terms of fixed asset (pans, net, drying platform, black polythene, knives, basket sieve, “cement wall”) to start a fish salting business is about GHS 632. Fish frying requires an investment cost of GHS 650 to purchase items like a stove, frying pan, basket, perforated ladle and net to start. Fish smoking requires a fixed cost of GHS 830 worth of investment to purchase one chamber stove, a pan, a basket, a knife and polyethylene.

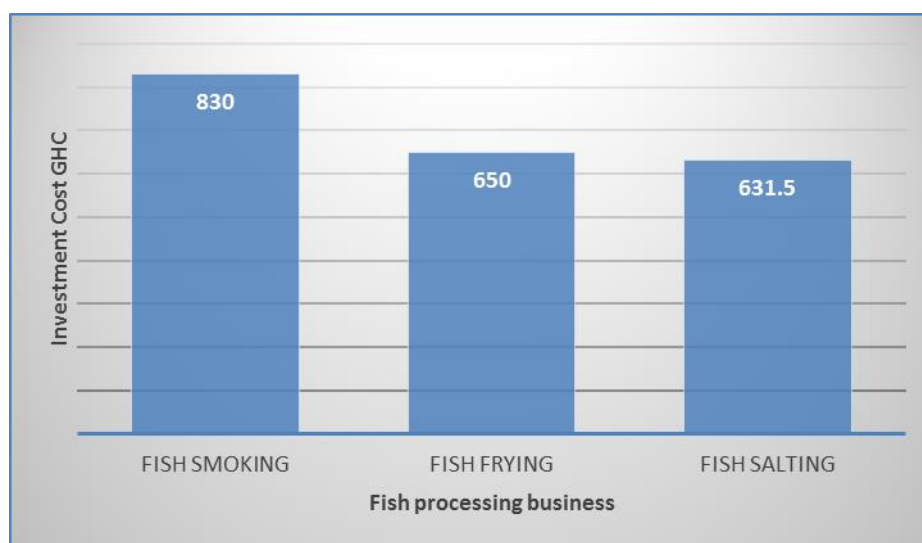


Figure 49: Initial cost of investment in Fish Processing Business

Fish smoking remains the most expensive livelihood option in the fisheries sector in terms of initial capital cost, followed by fish frying, with salting being the least expensive.

Production cost and revenue

The cost of production in each processing business was analyzed taking into consideration the production inputs. The revenue generated in each case was also analyzed. Table 8 shows the per kg cost of production and sales for the various fish processing options.

Table 8: Production cost, sales and profit (GHS) for fish processing options per kg end-product

Item	Fish salting	Fish smoking	Fish frying
Production Cost	4.55	7.72	5.04
Sales	9.09	13.33	5.65
Profit	4.54	5.61	0.61

Figure 50 shows that fish salting and fish smoking are the most lucrative processing options with a good profit margin (75-100%), which would account for the large proportion of women engaged in these sectors. Fish smoking is the dominant processing technique in the country due to the high demand for smoked fish in the country. Most fish processors do not engage in fish salting due to the bad smell during the processing phase but will use this process if the fish is going bad.



Figure 50: Comparing cost of production and revenue for fish processing options

Comparing production cost for all three businesses, fish smoking is the most expensive due to the cost of labor and fuelwood. Fish frying has a smaller profit margin as a result of the preferred fish species and the cost of oil. However there is a strong demand for the product and a high turnover. Fried fish is usually consumed with the popular “banku” or “kenkey” leading to demand throughout the year.

CONCLUSION

A careful study of the three fish preservation techniques - Smoking, Salting and Frying - revealed that each process has its peculiar advantages and disadvantages.

The fish smoking process, although more tedious and time consuming in comparison with frying and salting, has the most processors due to the large market demand and good returns. Fish and fuelwood are the highest contributors to the total cost of production. With the emergence of new stove technologies, the process will be more attractive to end-users through the reduction of drudgery and the enhancement of productivity and margins.

Fish frying, on the other hand, although tedious involves less work as compared to fish smoking. However it involves high production cost, when compared to the other two processes. Fish, Oil, and fuelwood are the highest contributors to the total cost of production. Though comparatively, fried fish has a shorter life span, there are a number of sales techniques that facilitate the distribution of the fish. Some fish processors sell their fish to bulk purchasers, or sell with ‘Banku’ or ‘Kenkey’ with pepper. Others also go hawking within their immediate communities by displaying the fish in various containers/receptacles. Thus the sale of fried fish is not limited to the market and can be sold at any time of the day. There are few fish fryers as compared to other processors, especially in Elmina.

Fish salting has the least cost and labor, and is expected to be the most profitable. It does not involve any form of heat and involves the least drudgery. Fish and salt are the highest contributors to the production cost. Salted fish has the longest shelf life and can be stored (for a year or more) till there is a better market for it. It is not produced in large volumes like smoked and fresh fish. It however has a ready market though it is used in smaller quantities in

food preparation. Fish salting is the most patronized processing technique after fish smoking. This rating may however differ from community to community

Specific value additions to each of the processes is likely to increase the sales options for the processed fish, and increase productivity.

RECOMMENDATIONS

It is very necessary for fish processors to be given some training on environmental compliance and healthy fish handling to ensure that the processors work with ease to produce safe processed fish for human consumption. Fish processors must also be encouraged to join commendable fish processing groups where they will be educated on the fisheries sector and issues pertaining to their specific processing options, as well as learn about new technologies that make processing easier and safer for both the processor and the consumer.

Fish processors must also be taken through some business development training to empower them and help them track the progress of their businesses.

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APPENDIX

LIVELIHOOD OPTIONS TOOL QUESTIONNAIRE FOR FISH PROCESSORS

Date of Interview
Community
GPS Coordinates
for the Fish
Processor [Shed]
Region
Name of
Enumerator

Long:

Lat:

Central Region []

Western Region []

SECTION A: Demographic Characteristic of Respondent

- A1 Sex of Respondent Female [] Male []
- A2 Educational Background No Schooling [] Primary []
Middle school/JHS [] SHS []
Post-Secondary [] Tertiary []
Non-formal Education []
- A3 Marital Status Single [] Separated []
Married [] Divorced []
Widowed []
- A4 Number of dependents 1 – 3 [] 4 – 6 []
7 and Above []
- A5 Age of Respondent 18 – 30 years []
31 – 40 years []
41 – 49 years []
Above 50 years []

SECTION B: THE BUSINESS NATURE

- B1 What form of Fish processing technique do you do?
- Smoking []
Salting []
Frying []
Fresh Fish []

Other specify:.....

B2 Why do you prefer this type of processing technique?

- B3 If given the opportunity, will you like to carry out a different processing activity other than what you are currently doing?
- Yes [] No []

- B4 If yes, which processing activity will you prefer and why?
- Smoking []
Salting []
Frying []
Fresh Fish []

Other (specify):
.....

Why?

B5 Describe the fish processing technique

Process:

Storage:

Market:

Logistics:

- B6 How long have you been in the Fish processing business? Less than 1 year []
 1 – 3 years []
 4 – 6 years []
 7 – 10 years []
 10 - 13 years []
 Above 13 years []
- B7 How often do you process in a week? Once []
 Twice []
 Thrice []
 Four times []
 Five times []
 Six times []
 All week []
- B8 Do you work all year round? Yes [] No []
- B9 If No, how many months in the year do you work? Jan [] May [] Sept []
 Feb [] Jun [] Oct []
 Mar [] Jul [] Nov []
 Apr [] Aug [] Dec []
- B10 Why do you work during this period of the year Bumper season []
 Other (Specify) []
- B11 Do you use stove in your processing? Yes [] No []
- B12 What fuel do you use for the stove Firewood [] Sawdust []
 Charcoal [] Agric waste []
 Other (Specific).....
- B13 How much do you spend on fuel (Specify volume of fish processed per day on average)? Daily [.....]
 Weekly [.....]
 Monthly [.....]
- B14 Why the choice of the stove you are using Cost of the stove []
 Design of the stove []
- [Please tick all that**

applies]

- Durability of the stove []
- Mobility of the stove []
- Inherited []
- Availability at time of purchase []
- Fuel Consumption []
- Emission of smoke []
- Capacity of the stove []
- Other (Specify):.....

B15 What are the most important factors you considered in the choice of stove [RANK in order importance mentioned by respondent]

- Cost of the stove
- Design of the stove
- Durability of the stove
- Mobility of the stove
- Emission of smoke
- Fuel Consumption
- Capacity of the stove
- Availability of technology

B16 How much did it cost you to construct/purchase the stove you are currently using?

(List materials needed for constructing the stove)

- Less than GHC 100 []
- 100-500 GHC []
- 600 – 1000 GHC []
- Above 1000 GHC []

B17 How many stoves (units) do you usually use at a time during the bumper season?

- One unit [Number:_____]
- Double [Number:_____]
- Triple [Number:_____]

B18 Why do you need this number of stoves at a time?

- Avoid spoilage []
- Save time []
- Other (Specify).....

- B19 How many stoves (units) do you usually use at a time during the lean season? One unit [Number: _____]
 Double [Number: _____]
 Triple [Number: _____]
- B20 How many pans/cartons of fish do you usually process per week during the bumper fishing season? Pans: [_____]
 Cartons:[_____]
- B21 Do you usually process fish during the off season Yes [] No []
- B22 How many pans/cartons of fish do you process per week during the off/lean season? Pans: [_____]
 Cartons:[_____]
- B23 Where do you usually buy your fresh fish from during the off-season for processing/ selling? Cold store [] From a Friend []
 Fishermen []
 Other (specify):.....
- B24 What types of fish stock do you usually process? Tuna [] Barracuda []
 Sardinella [] Horse Mackerel []
 Red fish [] Anchovy []
 Other (specify):.....
- B25 Do you undertake any other economic/livelihood activities during the off fish season? Yes [] No []
- B26 If Yes, what form of economic/livelihood activity do you undertake? Petty Trading []
 Farming []
 Agro Processing []
 Livestock rearing []

Other

(Specify):.....

SECTION C: BUSINESS ASSETS AND OPERATIONS

C1 What form of equipment/assets do you have for your fish processing business?
[TICK AS APPROPRIATE AND INDICATE THE QUANTITIES AND COST] OBSERVE THE EQUIPMENT AROUND

Canoe/Boat
Smoking Tray
Pans
Stove
Processing Shed
Knife
Processing mats
Refrigerator
Processing table
Vehicle/Motorking truck
Basket
Outboard motor
Frying pans
Frying ladles
Other (specify):

C1 Where did you obtain the **main** capital to start your fish processing business?

Bank []

C2 Where did you obtain the **main** capital to start your fish processing business?

Universal Bank []
Rural and Community Bank []
Microfinance Company []
Susu Enterprise []
Other
(Specify):.....

C3 Do you incur cost in logistics maintenance?
If yes how much cost do you incur annually?

Yes [] No []
[] Less than GHC 50
[] GHC 60 - GHC 100
[] GHC 200 – GHC 500
[] GHC 600 – GHC 1000

List the maintenance areas

-
-

- C4 Do you own a storage facility? Yes [] No []
- C5 If yes, describe your storage facility
- C6 If No, where do you usually store your processed fish?
- C7 What is average size of your business capital for fish processing? [] GHC 100 - GHC499
 [] GHC 500 – GHC 1000
 [] GHC 1,100 – GHC 1,999
 [] GHC 2000 – GHC 3,999
 [] GHC4000 – GHC 4,999
 [] Above 5000
- C8 Do you operate a savings account? Yes [] No []
- C9 If Yes, with which Financial Institution? Universal Bank []
 Rural and Community Bank []
 Microfinance Company []
 Susu Enterprise []
 Other
 (Specify):.....
- C10 Have you ever taken a loan from any Financial Institution for your business? Yes [] No []
- C11 If Yes, from which Financial Institution? Universal Bank []
 Rural and Community Bank []
 Microfinance Company []
 Money Lender []
 Susu Enterprise []
 MASLOC []
 Other
 (Specify):.....
- C12 Who are your customers? A friend/Relation []
 Bulk Buyer/Aggregator []
 Another fish processor []
 Any Available customer []

Other
(Specify):.....

- C13 Where do you usually sell your processed fish?
Market []
At home []
At Processing site []

Other
(specify):.....

- C14 If Market, which type of market do you usually go to sell your processed fish?
Local/Community market []
District market []
Regional market []
Outside Ghana []

List market centers

Others
(specify):.....

- C15 What mode of transport do you often use in sending your processed fish to the market?
Motorking truck [] Tricycle []
Public transport [] Cargo Truck []
On-foot/Walk []

Other
(specify):.....

- C16 How much do you usually pay per trip on transport in Ghana Cedis?

GHC_____

- C17 At what times do you usually sell your processed fish?
On market days []
Daily basis []
Weekly basis []
As and when available []

Other
(specify):.....

- C18 How do you package your processed fish for sale
Paper packaging []
Bowls []
Rubber bags []
Baskets []

- C19 What is the cost per unit? In relation to C17
[]

- C20 What is your average volume of fish you take to the market at a time; by unit package and cost?
- 1 – 5 baskets [] GHC
- 6 – 10 baskets [] GHC.....
- 11 – 15 baskets [] GHC.....
- 16 – 20 baskets [] GHC.....
- Above 20 baskets [] GHC
- C21 What is your average monthly sales in terms of fish processed?
- GHC 100 – GHC 499 []
- GHC 500 – GHC 999 []
- GHC 1000 – GHC 2000 []
- Above GHC 2000 []
- [Estimate weekly sales with respondent first and then assist respondent to calculate the sales for the month]*
- C22 At any given time, what resources do you put into your business and what are your returns?
- On average what is your weekly profit?
- | Input | Profit |
|----------------------|-------------------------|
| Fish [] GHC..... | less than GHC 100 [] |
| Fuel [] GHC..... | GHC 100 – GHC 499 [] |
| Salt [] GHC..... | GHC 500 – GHC999 [] |
| Oil [] GHC..... | GHC 1000 – GHC 1999 [] |
| Labor [] GHC..... | |
| Other (specify)..... | |
- C23 Do you belong to any fish processor group?
- Yes [] No []
- C24 If Yes, which group do you belong to (name of group) and why did you join the group?
- Group name:
- Why?
- C25 If yes, is the group process specific?
- Yes [] No []
- How many are you in the group?
- C26 If No, are there any reason(s) for not joining any of the fish processor group

C27 Would you encourage your child or close relative to take over from you or do this kind of business and why? Yes [] No []
Why?

C28 Does your work have some implications on your life? Yes [] No []
Implications:
If yes what are these implications?

C9 Please rate your business in entirety
Subsistence []
Small []
Medium []
Large []

What are your immediate business needs?

Business Address

Name of Processor -
Contact Phone Number -
House Number -