A CASE STUDY OF UTILIZATION OF FUEL WOOD FOR FISH SMOKING/DRYING INDUSTRY IN GHANA

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SUMMARY

A study of the utilization of wood fuels in fish smoking/drying industry in Ghana has been carried out. Fish smoking/drying is a very important occupation for most illiterate women living along coastal Ghana and in a few inland towns and villages. The process accounts for about 60-70% of the total fresh fish landings. Cylindrical and rectangular traditional ovens are used for smoking. Firewood is used as fuel for fish smoking. Various woods are used and the qualities looked out for in selecting the woods include the following, ability to burn slowly to generate heat and smoke, ability to impart a nice colour to the smoked fish and, the cost of the wood. It was difficult to assess the quantity of wood used to smoke a known quantity of fish.

INTRODUCTION

Title and Terms of Reference

The title of this study is a "Case Study of the Utilization of Wood Fuels in the Fish Smoking/Drying Industry in Ghana". The terms of reference are as follows:

- General description of the importance of fish smoking/drying for the country's global consumption of wood at National and/or Regional levels and the main geographic location where such activities are carried out.

- Technical description of fish smoking procedures, equipment used, wood conversion energy systems normally used.

- Description of the characteristics of wood fuels used in terms of quantity, quality, types and sources of supply including consumption patterns.

- Economic analysis of using wood fuels as a source of energy.

The art of fish smoking in Ghana is a very old one and has been practiced as one of the many ways of processing fish in order to preserve it since fish is a highly perishable commodity. Fish smoking/drying ranks first among the fish processing/preservation methods used in Ghana, accounting for about 60-70% of the total fish landings.

Although fish smoking has been practised for a long time, the methods used are still at the traditional level. James (1976), who claimed that in the developing countries of the world, the methods used in fish processing are traditional, confirms this.

GHANA – AREA, LAND-USE AND FUEL USE

Ghana is situated between longitudes 3^0 15^W and 1^0 12^E and latitude 4^0 44^S and 11^0 10^N. The total geographical area of the country is 238,000km^2, with a total land area of 266,000km^2. The Volta Lake covers 7700km^2. The population of Ghana is estimated at 12 million for 1984 with a mean annual growth of 2.7%. Urban population is estimated at 4,063,000 for 1980.

The country is divided into two broad ecological zones namely:

- The closed Forest Zone covering 82,260km2 in the southern part of the country and,

- The Savanna Zone covering 156,270km2 largely in the northern section.

A narrow belt of coastal thicket and grassland is found along the coast of Ghana from the eastern end of the western region. This zone locally designated southern savanna, fans out towards the east in the Greater Accra and Volta Regions to form an almost continuous belt with the Northern Savanna Zone. The major part of the Savanna Zone is made up of dense Savanna woodland. The closed Forest Zone embraces the Western, Central, Ashanti and Brong Ahafo Regions and the Savanna Zone, the Upper, Northern, Eastern, Volta and Greater Accra Regions. Sections of the administrative Eastern and Volta Regions are however under closed forest, whilst parts of Central and Brong Ahafo Regions are covered by Savanna Woodlands.

Land-Use Distribution

Pattern of land-use, as at the end of 1975 in the above mentioned two zones is given in the tables below:

Table 1 Land-Use in the Forest Zone

Land-Use	Area '000ha	Percentage
Forest Reserves (permanent forest estate)	1679	20.41
Unreserved Forest (potential farmland and private commercial forest)	265	3.23
Total	1944	23.64
Other lands/cocoa, food farms and bush fallow	6282	76.36
Grand Total	8226	100.00

Table 2 Land – Use in the Savanna Zone

Land - Use	Area '000ha	Percentage
Forest Reserves	881	5.63
Unreserved Woodlands	8480	54.27
Total	9361	59.90
Other lands/Grasslands, Farms etc	6267	40.10
Grand Total	15628	100.00

It is estimated that 4,600ha of the closed Forest Zone and 38,300ha of the Savanna Woodland is lost annually (Forest department Records). The extent of plantations established by the Forestry Department as at 31st December 1979 is given as 50.310ha (Forestry Department Statistics). The breakdown according to end-uses envisaged is as detailed below:

Table 3 Breakdown of End-Use of Plantations Established by Forestry Department

Plantations	
Industrial Plantations Broadleaved	43,000ha

Coniferous	10ha
Fuel Wood Plantations Broadleaved	8,300ha
Total	**51,310ha**

Fuel wood plantation thus, make up only 16.5% of the total national plantation effort. The distribution of plantations within the Forest and Savanna Zones is as follows:

Table 4 Distribution of Plantations within Forest and Savanna Zones

	Fuel Wood	**Industrial**
Forest Zone	1500ha	43,010ha
Savanna Zone	6800ha	-
Total	8300ha	43,010ha

Fuel Wood Consumption

Out- turn of fuel wood in the Regions of Ghana in 1976 is indicated below:

Table 5 Out-turn of Fuel Wood in the regions of Ghana

Zone	**Firewood Out-turn m^3**	**Charcoal Out-turn m^3**
Forest		
Western/Central Region	3,783,264	578,504
Ashanti/Brong-Ahafo Region	3,314,952	108,081
Total	**7,103,216**	**686,585**

Savanna		
Eastern/Volta Region	2,591,788	343,744
Upper Region	685,992	17,053
Northern Region	788,551	15,771
Total	**4,066,331**	**376,568**
Total Ghana	**11,169,547**	**1,063,153**

(Source: Forestry Department Annual Report)

Since there is no record of import or export of fuel wood, it may be assumed that consumption is equal to production.

Fuel wood is the major source of energy for the rural population making up about 80% of the total population of Ghana. It is also estimated that 90% of the urban population meet part of their domestic energy requirement from fuel wood, mainly in the form of charcoal. Various industrial establishments use large quantities of fuel wood. These include team boilers in sawmills, potteries, bakeries and fish smoking industry.

An increase in the industrial use of fuel wood is anticipated to meet requirements for projected iron ore and lime stone exploitation and production of calcium carbide. Earl (1977) forecast industrial requirement for 1982 is shown in Table 6.

Table 6 Forecast Industrial Requirement for 1982

Industrial Requirements	**Quantity/Tons**
Iron and steel	100,000
Ferro sihion	30,000
Calcium carbide	30,000
Foundry work	6,000
Total	**166,000**

He further forecasts future demands for charcoal as indicated in Table 7.

Table 7 Future Demands for Charcoal in Ghana

Sector	1977	1982	1990
Rural	23,000	25,000	27,500
Urban	137,000	175,000	257,000
Industrial	-	166,000	300,000
Total	**160,000**	**366,000**	**584,500**

The above indicates a trend towards increased consumption of wood energy.

TECHNICAL DESCRIPTION OF FISH SMOKING IN GHANA

The Fish Smoking Industry

Smoking is a method of processing fish, which combines the following three effects:

- Preservative value of the smoke: the smoke produced from burning of wood contains a large number of compounds some of, which will kill bacteria, for example, phenols.

- Drying: the fire, which produces the smoke, also generates heat and this dries the fish.

- Cooking: the smoking is done at temperatures high enough to cook the fish, destroy enzymes and kill bacteria.

Fish smoking/drying is the most popular method of processing fish in Ghana accounting for about 60-70% of the total fish landed. Various types of fish are smoked. The process as carried out in Ghana, involves subjecting the fish to heat and smoke generated by burning firewood. It is normally carried out on

commercial scale and women (predominantly illiterates) are mainly engaged in this activity. Most of these women are borne into the fish smoking business. Basically they operate on two main bases namely: Personal and Partnership.

Personal – under this, the leader of the team is the sole owner of the business, but other people who are usually relatives may assist her.
Partnership – in this case, the business is owned jointly by two or more partners, with each having a share capital. However, they may also have helpers.

Fish smoking is a very important economic activity carried out both in the urban and rural coastal towns and villages as well as towns and villages along the Volta Lake/River. With improvement in transportation and the establishment of cold storage facilities in the regions of the country, fish smoking industries have been set up in cities like Koforidua (Eastern Region), Sunyani (Brong-Ahafo Region), Kumasi (Ashanti Region), Tamale (Northern Region), and Bolgatanga (Upper Region) using frozen fish.

As stated earlier, fish smoking is a method of preservation effected by a combination of drying and the deposition of naturally produced chemicals resulting from the thermal breakdown of wood. In Ghana fish is smoked to achieve the following goals:

Preservation – to prolong its shelf life
Taste – to enhance its flavour and increase its utilization in Ghanaian soups and sauces.
Increase income – to reduce waste at times of bumper catches and to store for the loan season.
Better Nutrition – to increase protein availability to all people throughout the year.
Improved Marketing – to make it easier to pack, transport and market.

Wood Conversion

The burning of wood to produce smoke is an incomplete combustion process and the smoke produced will vary with the source/type of the wood and the ventilation of the fire. Wood smoke is a mixture of gases, vapours and droplets. The droplets form the visible part of the smoke although the invisible vapours contribute to the characteristic smell. It has been shown that it is mainly the vapours that are taken up by fish during smoking. The substances in the vapours dissolve in the liquid on the surface of the fish and the rate of their uptake depends on the moisture on the surface of the fish and the rate of flow of the smoke. The gases present in smoke include the following; carbon monoxide, carbon dioxide, hydrogen and hydrocarbons. The droplets consist of acids and derivatives, alcohols, aldehydes, ketones, hydrcarbons, phenols and pyridines. The vapour is made up of valeric aldehyde and furans, phenols and their derivatives. The acids and phenols have been found to be responsible for colour and the flavour of the smoked fish as well as keeping down bacterial activity. The phenols in smoke are derived from lignin in the cell walls of wood, the type of phenols present in smoke will therefore depend on the type of wood used for smoking. The type of wood used however is much less important than smoking sufficiently to give adequate flavour and preservation.

Types of Fish Smoked

Marine, lagoon and fresh water fish of various species, shapes and sizes are smoked. Examples of fish commonly smoked are given in Table 8. Fresh as well as frozen fish are smoked, and the use of any of the types is determined by the location of the processing site and availability.

Fish Smoking Equipment

The smoking equipment consists basically of a chamber in which fish are placed over a smouldering fire. The equipment is popularly known as an oven although it is not an oven in the true sense of the word. Two main types of fish smoking ovens are used in Ghana. They are Cylindrical, and Rectangular Ovens. The

ovens are traditional and are not of standard specifications and also vary in the materials used for construction. Certain types are however specific to certain area of the country.

Cylindrical Ovens

There are two basic types of the Cylindrical Oven namely, Oil Drum Oven and Cylindrical Mud Oven.

Oil Drum Oven

This oven is constructed from empty, 44-gallon oil drum. Two or more drums are opened and joined together to form a larger cylinder. A stoke hole is cut on one side of the oven, a metallic grill is fitted about a third from the top of the oven to form a compartment where the fish is arranged for smoking. The sizes of a few samples examined were as follows: Height 75-108cm; thickness 0.3 or 0.5cm and the circumference 252 – 416cm; diameter 85 – 144cm. It has an average volume of 235,516cm^3 and a life span of 3 years. The main advantage with using this oven is that it can be easily transported to follow fish landing locations. But it the advantage of becoming rusty as a result of corrosion from sea breeze. The use of this oven was found to be on the decline due to the scarcity of empty oil drums in the system.

Cylindrical Mud Oven

Due to the wide usage of the Cylindrical Mud Oven in the Central Region of Ghana where Fantes live, this oven type is also known as the Fante Clay Oven. The oven is cylindrical in shape, and constructed from local clay. Covering the outside with concrete plaster may reinforce it. A wooden or metallic grill is fitted to the oven about one-third from the top of the oven and a stoke hole provided. The average dimensions are: circumference 383cm, diameter 124cm; height 85cm; thickness 10cm and average volume 397,874cm^3; average life span 3 years but if not reinforced and protected from rain, the life span can be as short as one month.

Rectangular Mud Oven

This oven, as the name implies, is rectangular in shape and is constructed with local clay and sand mixture and used mostly in Accra and a few villages near Accra. The outside of the oven may be covered with cement phasing. There are variations in the rectangular ovens. Some ovens have movable trays/wire nets on which fish is arranged for smoking, and other ovens still use unframed pieces of wire nets. All the rectangular ovens were originally using the unframed wire net, until 1969/71 when the Food Research Institute, in conjunction with FAO introduced the framed wire net trays, which have now become very popular with the traditional processors. The advantage associated with used of the framed trays is that it allows stacking of the trays and therefore more fish can be smoked at a time without bruising the lower layer of fish. The following are the range of specifications of the rectangular oven: height 58 –79cm; length 195-232cm; breadth 102-138cm; thickness 11-20cm; capacity using framed wire nets 1,406,024cm^3. The smoking trays are of the following dimensions: height 6-9cm; length 178-215cm; breadth 90-112cm. Larger forms of the trays are used for storage of the smoked fish and these are of the following specifications: height 13-17cm; length 178-215cm; breadth 91-112cm. The rectangular oven has a life span of about 8 years when cement-faced and 4 years if bare mud but well covered when it rains.

Pre-Smoking Practices

Fish is never salted before smoking in Ghana. Depending on the type of fish to be smoked, the fish may be scaled, gutted, cut up into chunks or not scaled or gutted at all. The big sized fish like Tuna, Grouper, Sea bream and Snappers are cut up into pieces and the head is cut off and divided into two and the gills removed. All types of fish are washed with either sea or fresh water whichever is available before they are smoked. The cleaned fish are arranged nicely on the ovens. The pieces of firewood are also arranged in the stoke holes

The Smoking Process

The fire is set up in the stoke holes using dry firewood. Without pre heating the oven, the fish are subjected to heat and smoke. Depending on the type of fish to be smoked (species, thickness, and way of cutting), what it will be used for, and the length of time it may be stored, the smoking process can take anywhere from 1 hour to 2 days. Large sized fish are turned during smoking by hand singly when using either rectangular or cylindrical ovens and small sized fish are turned singly only when cylindrical oven is used. Where smoking trays are used overturning the tray of fish onto an empty tray and hitting the back of the wire mesh to drop the fish turns the fish. While turning the fish, it is rearranged on the wire mesh and oven so that the less smoked side is placed closer to the fire and smoke.

None of the smoking ovens described have devices for the control of temperature and smoke. The fire is therefore witched closely during the smoking and as soon as it becomes too intense, some of the firewood is removed. The smoking process is however started with a low fire and temperature and the heat increased gradually to cook the fish. Towards the end of smoking process, some crushed sugar cane is added to the fire in order to impart a yellowish-brown colour to the smoked product. The long storage life of some smoked fish products has been found to be more due to drying and cooking of the fish than to the preservative value of the chemical compounds deposited on the fish from the smoke. The following reactions are believed to take place during smoking:

- Vapour absorption of acids and carbonyls.
- Fall out of tarry droplets and
- Condensation of smoke on the colder fish surface.

Smoked Fish Products

Basically two types of smoked fish products are produced in Ghana. These are, Hot Smoked and Smoke Dried fish. Hot Smoked fish is smoked over a smouldering fire for 2-5hours to cook the fish without drying it. It is therefore

succulent with moisture content of 50-70%, and has a shelf life of 1-3days. Smoke Dried fish is smoked using fire of higher temperature and smoked for a longer period of time which may be hours to days, so that the fish in addition to being cooked is dried to low moisture level of 10-15%. This product has a potential shelf life of 6-9 months. Smoke Dried fish is more widely used because in this form, storage, transportation and marketing are made easier.

FUEL WOODS USED FOR FISH SMOKING

Various trees are used as fuel for fish smoking in Ghana. A list of the common types of trees used for fish smoking is given in Table 9. In general hardwoods are utilized and sometimes the type of wood used depends on the locality. Some of the qualities looked out for in selecting the firewood include, ability to burn slowly to generate heat and smoke, ability to impart a nice colour to the smoked product, and cost of the firewood.

In practice however, a mixture of wood is used for fish smoking. Most of the wood is collected from the forest areas of the country and transported in the dry state to the coastal areas in trucks where it is sold direct to the fish smokers. The Fish smokers normally buy the firewood in bulk and stored at the processing sites. In areas where firewood is difficult to obtain, any available material, which is capable of generating heat and smoke, may be used. Examples are dry grass and herbaceous plants. Other forms of fuel used are dry husks of coconut fruit, bagasse, dry cassava peel, some creeping plants and wet paper cardboard. These materials are however added towards the end of the smoking process when they are used to generate smoke. Sugarcane bagasse imparts a glossy golden brown colour and some sweetness to the smoked product.

It is difficult to assess the quantity of fuel used to smoke a known quantity of fish by the fish smokers because they do not take such records. They buy the firewood in large quantities and use over a period for restocking when necessary.

ECONOMIC ANALYSIS OF USING FUEL WOOD AS SOURCE OF ENERGY

In Ghana, fuel wood and charcoal are the main source of energy. Charcoal is processed from wet wood using traditional methods. Fuel wood is the major source of energy for the rural population making up about 80% of the total population of Ghana. It is estimated that 90% of the urban population meet part of their domestic energy requirement from fuel wood, mainly in the form of charcoal.

Various industrial establishments use large quantities of fuel wood. These include steam boilers in sawmills, potteries, bakeries and fish smoking industries. An increase in industrial use of fuel wood is anticipated to meet requirements for projected iron ore and limestone exploitation and production of calcium carbide. There is therefore a trend towards increased consumption of wood energy.

Unlike certain commodities, which have fixed costs, fuel woods do not have uniform or fixed costs in Ghana. Fuel wood is not sold by weight but by number whilst charcoal is sold in jute bagfuls. Although it is difficult to assess the cost of fuel wood and charcoal, it is generally estimated that charcoal is about three times as expensive as firewood. It is also difficult to assess the expenditure on fuel wood for fish smoking because most traditional processes are done without proper planning and management so that proper recordings of expenditures made on fuel wood are not done.

DISCUSSIONS AND CONCLUSION

Fish smoking is a very important occupation in Ghana, which is predominantly practised by illiterate women living mainly along the coastal areas of the country. Fish smoking constitute the main business activity and the main source of income for many families. The fish smokers have over the years acquired

remarkable skill in the smoking process. The Chorkor Smoker, an improved traditional oven has become very popular with the traditional fish processors.

Various woods are used for fish smoking. There are agents who deal only in the sale of fuel wood. The agents cart the fuel wood in truckloads from the forest areas to the fish smoking sites where the fuel wood is sold in bulk. The cost of fuel wood, like everything else keeps on rising in Ghana and this is reflected in the cost of the smoked fish, which is also increasing. In spite of a few limitations and constraints such as: high cost of materials and inputs resulting in increased cost of construction and maintenance of ovens, lack of easily accessible financial credit facilities, and irregular supply of fish.

He fish processors in general find fish smoking to be a very rewarding business. This was found to so more by the fish smokers using the Chorkor Smoker because the unit cost of smoking fish using the Chorkor Smoker was lower than the traditional ovens.

Most traditional processes including fish smoking are done without proper planning and effective utilization and management of the available resources. Therefore expenditures made of fuel wood and other items are not recorded resulting sometimes in unnecessary losses. It is thus difficult obtaining information on some important figures/estimates concerning fish smoking from the traditional fish processors. It is recommended for consideration that a study be carried out to assess in detail, the quantity of fuel wood used for smoking fish in terms of kilogram of fuel wood per kilogram of fish.

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APPENDIX

Table 8 Common Species of Marine Fish Smoked in Ghana

Scientific Name	English Name	Hot Smoked	Smoke Dried
Caranx spp.	Jack Mackerel	X	
Trachurus spp.	Horse Mackerel	X	X
Decapterus chonchus	Scad Mackerel	X	
Chloroscombrus spp.	Bumper	X	X
Anchoa guineensis	Anchovy		X
Ilisha africana	Longfin herring	X	X
Sardinella spp.	Sardines	X	X
Brachydeuterus auritus	Burrito		X
Lutjanus spp.	Snappers	X	
Psedotolithus spp.	Cassava fish	X	X
Auxis spp.	Frigate Mackerel	X	
Scomber japonicus	Spanish Mackerel	X	
Epinephelus spp.	Grouper	X	
Lethrinus spp.	Sea Bream	X	
Thumus spp.	Tuna	X	
Sphyraena spp.	Barracuda	X	X

Table 2 Types of Wood Most Commonly Used for Fish Smoking in Ghana

FAMILY	GENUS	SCIENTIFIC NAME	ENGLISH NAME
Bombacaceae	Adansonia	*Adasonia digitata*	Boabab, Monkey bread
Euphobiaceae	Elaeophorbia	*Klaephorbia drupifera*	-
Rubiaceae	Oxyanthus	*Oxyanthus unilecularis*	-
Rhizophoraceae	Rhizophera	*Rhizophora spp.*	Red Mangrove
Combretaceae	Terminalia	*Terminalia ivvorensis*	Shingle wood
Flacourtiaceae	Caloncoba	*Caloncoba gilgiana*	-
Combretaceae	Terminalia	*Terminalia avicennoides*	-
Combretaceae	Anogeissus	*Anogeissus leiocarpus*	-
Verbenaceae	Vitex	*Vitex grandifolia*	God's Coconut
Lecythidaceae	Combretodendron	*Combretodendro marcocarpum*	Stinkwood tree
Sterculiaceae	*Nesogordonia*	*Nesogordonia papaverifera*	-
Caesalpinaceae	*Dialum*	*Dialium guineensis*	*Velvet Tamarind*
Irvingiaceae	*Irvingia*	*Irvingia spp.*	*Wild Mango*
Myrtaceae	*Psidium*	*Psidium guajava*	*Guava*
Rutaceae	*Fagara*	*Fagara xanthoxyloides*	*Candle Wood*
Sapotaceae	*Vincentella*	*Vincetella revoluta*	-
Meliaceae	*Trichilia*	*Trichilia prieuriana*	-
Papilionaceae	*Baphia*	*Baphia nitida*	*Camwood*
Verbataceae	*Vitex*	*Vitex doniana*	-
Sapotaceae	*Malacantha*	*Malacantha alnifonia*	-
Euphorbiaceae	*Bridelia*	*Bridelia atroviridis*	-
Bignoniaceae	*Crescentia*	*Crescentia cujete*	*Tree Calabash*
Meliaceae	*Azadirachta*	*Azadirachta indica*	*Neem or Mangosa tree*
Anacardiaceae	*Mangifera*	*Mangifera andica*	*Mango tree*