Improved fish smoking: Ghana

ABSTRACT

Fish is an important source of food and income to many people in the developing world. In Africa, some 5 percent of the population, about 35 million people, depend wholly or partly on the fisheries sector, mostly artisanal fisheries, for their livelihood.

Various traditional methods are employed to preserve and process fish for consumption and storage. These include smoking, drying, salting, frying and fermenting and various combinations of these. In Ghana, smoking is the most widely practised method: practically all species of fish available in the country can be smoked and it has been estimated that 70-80 percent of the domestic marine and freshwater catch is consumed in smoked form.

The advantages of smoking fish are manifold. Fish smoking prolongs shelf life, enhances flavour and increases utilization in soups and sauces. It reduces waste at times of bumper catches and permits storage for the lean season. It increases protein availability to people throughout the year and makes fish easier to pack, transport and market.

Fish smoking in Ghana is traditionally carried out by women in coastal towns and villages, along river banks and on the shores of Lake Volta. In most fishing communities, in fact, the main economic activity of women is fish processing. Depending on the type of fish to be smoked, its uses and possible storage period, the smoking process can take the form of "wet" hot smoking or "dry" hot smoking. Both processes are carried out at temperatures above ***80°C,*** which are high enough to cook the fish.

Until the end of the 1960s, the ovens most used for smoking fish in Ghana were cylindrical or rectangular and made of mud or metal. Using these ovens had considerable disadvantages, however, such as excessive handling of fish during smoking, a problem more severe when smoking small species of fish such as anchovies. The ovens had a low capacity, were inefficient in fuel usage and could not cope with the large volumes of fresh fish landed during bumper fish seasons. This contributed to high post-harvest losses and, since the fish season also coincided with the rainy season, the fish could not be sun-dried.

Because traditional ovens were inefficient, more firewood than necessary was used for the smoking process, which contributed to forest depletion. The

health of the women fish smokers was at risk, because the smoke entered their eyes and lungs, they burned their fingers and they were exposed to direct heat. The fish smoking procedure was very laborious and poor-quality smoked fish was produced.

In the early 1950s, awareness of the shortcomings of traditional ovens had stimulated development work on new and improved smoking ovens, such as the Adjetey, Altona, Ivory Coast and Nyegesi models. For various reasons, however, none of these was accepted when introduced in Ghana.

In the light of lessons learned from the constraints and disadvantages associated with these earlier ovens, an improved traditional fish smoking oven, the Chorkor, was developed and introduced in 1969. This innovative model, developed by the Food and Agriculture Organization of the United Nations (FAO) and the Food Research Institute of the Council of Scientific and Industrial Research (CSIR) in Ghana, has since demonstrated the potential of traditional technologies in meeting current challenges.

The Chorkor oven, named after a small fishing hamlet on the outskirts of Accra, has numerous advantages. It is cheap to make and can be assembled using locally available materials. Easy to use, with large capacity, low firewood consumption and shorter smoking times, it produces high-quality smoked fish.

This simple, highly effective fish smoking technology was popularized in Ghana through a number of training programmes and promoted using the participatory approach. Fish processors were involved from the outset in the implementation process, thus ensuring high acceptance and adoption rates. In each community, fish smokers were informed of the benefits of the Chorkor smoker and ten of them engaged in year-long fish smoking were chosen in each community. At least one mason and one carpenter were trained in each community to be responsible for the construction of additional ovens. As part of extension activities, a user manual was produced in English and French and a video cassette with an explanation of construction and use was produced for fish smokers, extension agents and students.

The innovation of the Chorkor oven has led to enhanced incomes, living standards and nutritional status in fishing communities in Ghana. Its success has encouraged younger women to take up fish smoking as a profession and led to integrated programmes resulting in further socio-economic and community development in rural areas.

Although initially developed for use in Ghana, the Chorkor oven has now received wide acceptance in most western, central and eastern African countries through a number of initiatives supported by multilateral and bilateral sources. To date, Cameroon, Ethiopia, the Gambia, Kenya, Lesotho, Nigeria, Sierra Leone,

TABLE 1
National fish production, imports and exports *(tonnes)*

Marine fish production	1993	1994	1995	1996
Ghanaian waters:				
Canoes	257 237	211 747	210 659	298 249
Inshore vessels	5 230	6 037	6 371	8 353
Industrial vessels	18 323	18 966	20 049	25 103
Shrimp vessels	1548	2 442	2 689	2 590
Tuna vessels	36 856	36 973	33 905	37 255
Total	**319 194**	**276 165**	**273 673**	**371 550**
Outside Ghanaian waters:				
Industrial vessels	–	11 001	62 816	76 454
TOTAL	**319 194**	**287 166**	**336 489**	**448 004**
Inland fish production:				
Lake Volta	40 000	42 000	52 000	60 000
Rivers, dams and ponds	12 000	12 200	13 100	13 580
TOTAL	**52 000**	**54 200**	**65 100**	**73 580**
Total domestic catch	**371 194**	**341 366**	**401 589**	**521 584**
Exports:				
Tuna	21 145	26 928	23 157	30 682
Fish	3 283	5 091	5 575	5 749
Shrimps	99	270	318	264
Total exports	**24 527**	**32289**	**29050**	**36695**
Total fish imports	**36 983**	**18 827**	**2 250**	**1 000**
Tuna sold locally	15 710	10 045	10 748	6 573
Total fish consumption	**383 650**	**327 904**	**374 798**	**485 889**

Source Fisheries Department, Ministry of Food and Agriculture, Accra

Tanzania (including Zanzibar), Uganda and Zambia have demonstrated enthusiasm for and commitment to adopting this simple and cost-effective technology. The user-friendly and environmentally safe Chorkor oven holds valuable lessons for countries from other regions in the developing world.

INTRODUCTION

Fish is an important component in the diets of many Ghanaians. The country's fisheries sector comprises long-distance boats, inshore vessels fishing on the continental shelf and an indigenous canoe fleet, which is scattered along the coast and inland lakes and rivers. The bulk **of** marine and freshwater fish is landed **by** artisanal fishermen.

Figures for national fish production, imports and exports for 1993-96 are given in Table 1.

In general, fish is made up of 70-84 percent water, 15-24 percent protein, 0.1-22 percent fat and 1-2 percent minerals. The high moisture content of fish renders

it extremely perishable. It has been estimated that in the high ambient temperatures **of** the tropics, fish spoils within 12-20 hours of being caught, depending on species and size.

The total fish catches landed between 1993 and 1996 were 383 650, 327 904, 374 798 and 485 889 tonnes respectively, of which about 70-80 percent was smoked. In 1971, a survey of consumer attitudes to processed fish showed that Ghanaian consumers preferred smoked dried fish to fresh fish.

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, the heat destroys bacteria resting on and inside the fish and enzymes in the guts 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 the length of time it may have to be stored, the smoking process in Ghana can take the form of wet hot smoking or dry hot smoking. Both processes are carried out at temperatures high enough to cook the fish. Wet hot smoking usually takes about 1-2 hours and yields a moist, versatile product with about 40-55 percent moisture content but a limited shelf life of 1-3 days. Dry hot smoking, which is usually preceded by the former process, takes about 10-18 hours, sometimes days, yielding fish with 10-15 percent 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 commonest method, since the distribution process of the smoked fish may take a long time and producers often want to store it for months while waiting for a more favourable market.

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 but, as far as Ghana is concerned, the process has proved relevant to:

- prolonging shelf life;
- enhancing flavour and increasing utilization in soups and sauces;
- reducing waste at times of bumper catches;
- storing for the lean season;
- increasing protein availability to people throughout the year;

- making fish easier to pack, transport and market.

Despite the fact that modem methods of fish preservation, such as freezing and refrigeration, are available to some extent, the demand still persists in Ghana for the traditional flavour, taste and colour 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 or oil-drum oven;
- the rectangular mud oven;
- 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 in 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.

Problems encountered by traditional fish smoking ovens

In the 1960s and 1970s, several types of traditional ovens were used for fish smoking. They could not cope with the large volume of fish landed, however, because of their low capacity and inefficient smoking process. This led to high post-harvest losses and use of more firewood than necessary, which contributed to forest depletion. The health of women fish smokers was also placed at risk as a result of the smoke entering their eyes and lungs, their fingers being burnt and exposure to direct heat. The smoking procedure was very laborious and poor-quality smoked fish of low market value was produced.

The way fish is arranged for smoking in traditional ovens, in layers one on top of the other, prevents efficient circulation of heat and smoke. The smoking has to be interrupted frequently to rearrange the layers to prevent charring of the fish. In cases where sticks are used to separate the layers, the sticks exert considerable pressure on the fish, often disfiguring the smoked product and reducing its market value. None of the ovens described below had devices for controlling temperature and smoke during the smoking process, which was done by adding or removing firewood as and when necessary.

Cylindrical mud oven

As the name implies, this oven is round and made of mud. It is widely used in the central and western regions of the country, taking the name Fanti from the inhabitants of these regions. The oven exists in various sizes but typically it has an external diameter of about 132 cm, internal diameter of about 105 cm and a

height of about 80 cm. A ledge is made in the wall at about 50 cm from the bottom of the oven, on which sticks can rest to support the layers of fish to be smoked. The layers of fish are separated by sticks. Pieces of wire mesh can also be used to hold the fish for smoking instead of the sticks. A 42-48 cm hole is cut at the bottom of the wall for feeding firewood into the oven.

Disadvantages associated with this oven are the excessive handling of fish during smoking due to frequent reshuffling and damage to the fish caused by the sticks used to separate the layers. This problem is more serious in the smoking of small species of fish such as anchovies *(Engraulisencrasicholus)* than in the smoking of larger species such as grouper ***(Epinephelu***spp.). Other problems are that the oven:

- wears out after one or two seasons;
- is time-consuming and smoky to operate;
- is fuel inefficient;
- produces an unevenly smoked product;
- has limited capacity.

Cylindrical metal oven

The oven is usually constructed by joining together two opened 44-gallon steel oil drums and cutting a stokehole at the base. The average diameter of the metal oven is about 115 cm, with a height of about 90 cm and a stokehole of approximately 40x40 cm. Iron rods are fitted about 60 cm above the base of the drum to serve as a support for the layers of fish. This oven has been used throughout Ghana as well as in some other African countries. It is light and portable but susceptible to rust and corrosion. It suffers from the same shortcomings as the cylindrical mud oven. In addition, since it is made of metal, it gives off considerable heat during the smoking process, to the discomfort of the processor.

Rectangular mud oven

This oven is rectangular in shape and constructed from mud. Thick iron bars are placed across the top of the base to support the layers of fish to be smoked. A stokehole is cut along one of the longer sides of the oven. The fish are arranged on pieces of wire mesh and placed on the supporting iron rods. Where more than one layer of fish is smoked, the layers are separated by sticks. This oven was mostly used in the Greater Accra and Volta regions. Disadvantages include:

- difficulty in handling the hot wire mesh loaded with fish during the smoking process;
- low capacity;
- loss of heat and smoke through the stokehole and round the layers of fish,

resulting in inefficient fuel use;
- damage caused by the sticks separating the layers of fish;
- excessive handling of fish during smoking;
- pieces of fish falling into the fire, especially if the wire mesh is damaged;
- difficulty in controlling the heat.

Rectangular/square metal oven

This oven is normally constructed from 44-gallon steel oil drums, which are opened and joined to give a rectangular or square shape. Wooden battens are sometimes used for reinforcement. Thick iron rods are placed on top of the base to support the fish arranged on pieces of wire mesh. A large stokehole is cut at the base of the side wall. The disadvantages of this oven are similar to those of the rectangular mud model. It also radiates a great deal of heat.

PRE-INNOVATION

In the early I950s, recognition of the shortcomings of traditional ovens boosted work on the development of new and improved smoking ovens in Ghana and other African countries. These included the Adjetey, Altona, Ivory Coast and Nyegezi ovens.

Adjetey oven

The oven, developed by the Fisheries Department of Ghana in 1962, is constructed from heavy metal and has a combustion chamber/firebox located at the side of an enclosed smoking unit. A metal tube connects the two chambers. There is a chimney on top of the smoking unit. The fish are arranged on metal trays placed in the smoking unit. The oven was not accepted by women, because of its high cost and operational inconvenience and because the final smoked fish product is not as dry as that from traditional ovens.

Altona oven

The oven originated in the former Federal Republic of Germany and was introduced in the 1970s by the German Volunteer Service to fish smokers at Biriwa, a fishing community in the Central Region. The oven consists **of** a combustion/firing chamber constructed of burnt bricks, with a stokehole at the bottom of the front wall. The metal smoking unit, which **is** fixed by concrete on **top** of the combustion chamber, is enclosed and has a chimney. The fish are skewered through the eyes with metal rods and hung in the enclosed chamber for smoking. The skewering process removes the eyes of the fish, however, which is unacceptable to consumers. Disadvantages of the Altona oven included the high cost, which

women could not afford, and the fact that hanging fish for smoking represented a departure from traditional smoking techniques to which processors were accustomed. Introduction **of** a modified version, known as the Altona-type oven, also proved unsuccessful.

Ivory Coast oven

This type of oven consists of a square wooden frame to which aluminium sheets are nailed to form the sides. The fire chamber is made from one-and-a-half 44-gallon oil drums joined together, with one end of the drums opened. A hole is cut out of the upper part to allow the smoke and heat to pass through to the fish loaded on trays. A perforated metal plate is suspended above the hole to serve as a spreader. Three trays made from wooden battens with pieces of wire mesh nailed across them are placed on top of the framework. Aluminium sheet is used to cover the entire structure to retain heat and smoke. The oven was introduced to Cote d'Ivoire and a number of other African countries but not Ghana. The Ivory Coast oven was not acceptable to fish smokers at Lake Chad, as they did not have sufficient funds to cover the cost of the oven and purchase fish to fill it. The drum fire chamber was found to be cumbersome. The poor colour of the smoked product and the high variability of the oven temperature also militated against the Ivory Coast oven.

Nyegezi oven

The Nyegezi oven, or fish smoking kiln, was designed by the Natural Resources Institute in the United Kingdom, and introduced first to Tanzania and later to Ghana in 1990. It was designed to heat fish solely by convection, isolating the fish from the fire to avoid direct heating by radiation. Air is heated in a furnace and diluted with air at ambient temperatures entering from ventilation holes at the side. After passing through the fish and heating it, the air enters a chimney, which channels it upwards. The suction created draws air into the furnace and dilution vents and maintains the current of hot air passing through the fish. The oven was originally designed to meet problems that were particularly significant in Tanzania: shortage of fuel, the fatty nature of the fish and the need to prepare a product that could keep for several weeks at ambient temperatures. In Ghana, the circumstances were significantly different and the oven did not offer **any great fuel-saving advantages** in **producing the type of cured fish required in** Ghana.

INTRODUCING INNOVATION

The Chorkor smoker is an improvement on a traditional fish smoking oven already

known and used in Ghana that proved to be readily acceptable to women who practise traditional fish smoking. It consists of a combustion chamber and a smoking unit with a set of trays. The combustion chamber is rectangular, twice as long as it is wide, divided by a wall down the middle and with two stokeholes in front. The recommended standard measurements of the combustion chamber are:

- length – 225 cm
- width – 112.5 cm
- height – 60 cm
- wall thickness – 12.5 cm
- width and height of stoke hole – *37.5* cm
- depth of fire pit – 15 cm

The combustion chamber is the base of the smoker and is generally constructed from mud, although burnt bricks and cement blocks may be used. The latter two are more expensive than mud and cement is not recommended, since it cannot withstand the high smoking temperatures. The top of the wall must be flat so that the trays fit flush and no smoke or heat can escape through gaps. The smoker is designed so that the wooden frame of the trays rests along the midline of the base walls so that they are firmly supported and do not catch fire.

The smoking unit consists of a set **of** 5-15 smoking trays, depending on the size and quality of fish to be smoked. On average, however, ten trays are used per oven for small to medium-sized fish such as anchovies, mackerel and sardines. Five trays are used for large fish such as tuna, groupers and snappers. Over the years, *wawa* wood *(Sterculiaceae triplochiton)* has proved ideal for construction of the trays, the average depth of which is 6.25 cm. Wire netting of 1.25 to 2.5 cm mesh and 18-20 gauge is required, although bigger meshes with thinner gauges are used if nothing else is available. The wire mesh normally comes in *5* m rolls, sufficient for 22-25 trays. In addition, *7.5* and *3.75* cm nails are required to frame a tray and batten down the wire netting.

Some key features of the design are:

- The top of the oven wall must be square, level and flat, **so** that the wooden-framed trays can rest flush on the walls, leaving a *5* cm space from the frame wall to the inner wall of the base.
- Stokeholes should be in the middle of the smaller side of the base and arched for greater structural strength. They must be large enough for stoking and removing firewood **but** not so large as to permit heat and smoke to escape.
- The smoking chamber should be low for ease of stacking up to ten or more trays but the fire should be at least 50 cm from the lowest tray. **A** 10-15 cm fire pit should therefore be dug for each stokehole.
- Trays must be square and fit flush together in order to form a proper chimney.

- The wire mesh must be stretched in both directions across the bottom of the frames in order to support about 20 kg of fresh fish per tray without sagging.
- The wooden frames can last three years and the wire mesh about two years if the trays are properly constructed and maintained.
- Trays about 15 cm deep have been developed in some fishing communities and used for storage of smoked fish over several weeks.
- Each oven has a sheet of plywood that is used as a cover and for regulating smoke and heat in the smoking unit.

POST-INNOVATION

As a result of the constraints and disadvantages associated with traditional ovens and the bad experiences associated with those subsequently introduced, the Chorkor smoker was developed in 1969 as an improvement on the traditional rectangular mud oven used in some fishing communities in Ghana.

Before development of the smoker, a thorough survey was conducted throughout the country to assess the fish smoking industry, the methods and equipment used, the types of smoked product, the people involved in the business and the strategies for marketing. It was accepted that whatever new idea was introduced to the traditional smoking business, it was more likely to be accepted if it were based on the existing system familiar to fish smokers. In addition, it had to be simple, easily adaptable, inexpensive and, above all, easy to construct and use. Other preconditions were user awareness of and involvement in the new idea from the beginning and local availability of the materials needed for construction.

At the Chorkor community in particular, both rectangular and round mud ovens were in use. The rectangular ovens were used for the initial smoking process of cooking the fresh fish, which was then transferred manually into the round mud ovens for further smoking until very dry. In the design of the Chorkor smoker, these two processes were combined to enable the entire smoking process to be done in one oven.

In 1969, the first Chorkor smoker designed at the Food Research Institute in Accra was constructed. It comprises two chambers: a fire chamber and a smoking chamber. The fire chamber is the base of the smoker and has the following features:

- it may be rectangular or square;
- it can be constructed from mud or bricks;
- it can have one or more chambers, each with a conical stokehole;
- the height of the base is 60 cm;

- the wall thickness is 16 cm;
- it uses firewood as fuel.

The smoking chamber contains a set of trays constructed to fit the size of the base. The trays are made of wood-framed wire mesh. On top of the set of trays is a sheet of plywood used as a cover. On average, ten smoking trays are used per oven.

It was presented as a sample to two large-scale fish smokers at the Accra West suburb of Chorkor, hence the name. The two fish smokers were operating their business together and they indicated their willingness **to** accept and use the Chorkor smoker prototype and give their findings and comments.

The location for the prototype was a site at which other fish smokers were operating, so that as the technology was being used by the two volunteers, colleagues around them could observe and learn how the oven operated. The objective was to gain their interest in the new idea.

Six months after the introduction of the smoker to Chorkor, the following general views on the performance of the technology were provided by the fish smokers:

- The smoking process became less tedious with the use of the trays.
- More fish could be smoked in the improved oven, because with the framed wire mesh the fish could be arranged right into the corners and up to ten trays could be placed in one oven.
- The trays formed a chimney to trap the smoke and heat, leading to more efficient firewood use from improved heat and smoke circulation, so more fish could be smoked over a shorter period.
- With the plywood cover, the heat and smoke required during the smoking process could be regulated to some extent, thus obtaining a uniformly smoked product **of** better quality in terms of colour, shape and taste.
- Handling of the fish during the smoking process was greatly reduced.
- The product acquired a higher market price.

By this stage, more fish smokers in the Chorkor area were showing interest in the new technology and expressing their desire to own their ovens. Between 1969 and 1971, with **a** small grant from the Freedom From Hunger Campaign (FFHC), more Chorkor smokers were constructed and sold to interested fish smokers at the same cost as their traditional rectangular mud ovens.

Gradually, use of the new technology spread within the Chorkor community as more fish smokers realized its advantages and were prepared to adopt it. At this stage, the fish smokers were making their own arrangements for building the smoker. A number of carpenters and masons in the area had studied the construction of the smoker and began replicating it for women fish smokers for a fee.

Following the ready acceptance of the technology by the Chorkor fishing community, various means were used to extend the use of the smoker to other fish-processing communities elsewhere.

From 1982-86, FAO, the International Labour Organisation (ILO), the United Nations Children's Fund (UNICEF), the United Nations Development Programme (UNDP) and the United Nations Educational, Scientific and Cultural Organization (UNESCO) financed various projects promoting the Chorkor smoker in the Greater Accra, Volta, Central and Western regions of Ghana. The Food Research Institute, the initiator of the innovation, provided technical support in all cases.

Generally speaking, the participatory approach was used to promote adoption of the new technology. In each community, fish smokers were informed of the Chorkor smoker and ten women processors were selected, each of whom had to provide the required quantity of mud and water and participate in construction of the oven base. The project provided materials for the construction of the framed trays – wire mesh, split pieces of *wawa* wood and nails – and paid for the cost of labour for construction. One Chorkor smoker was constructed for and owned by each of the ten processors, thus maintaining individual working patterns. At least one mason and one carpenter were trained in each community to be responsible for the construction of any additional ovens required.

A manual on the smoker entitled *A practical guide to improved fish smoking in West Africa* was published in English and French as **part** of extension activities funded by UNICEF in Ghana in 1982-83. A video cassette, *Improved fish smoking in the tropics,* an educational programme for fish smokers, extension officers and students, was produced in 1986. Both gave prominence to construction and use of the Chorkor smoker. Presentations on the smoker were also made at national, regional and international workshops, seminars and conferences, including presentations from workers who had tried the smoker in other countries such as Benin, Sierra Leone and Tanzania.

In **a** report on the FA0 expert consultation on fish technology in Africa in 1985, it was recommended that FA0 should conduct a comparative evaluation of some of the fish smoking ovens in common use or which had been introduced **to** Africa. This became the subject of an FA0 technical cooperation programme (TCP) project, which was jointly implemented by the Food Research Institute and an **FA0** consultant. Under this project, an assessment was made of the performance of the Chorkor smoker, the traditional round mud and metal ovens and the Altona, Ivory Coast and Pit ovens, the latter type using a method in which fish is smoke-dried on branches covering a pit in the ground.

The study showed that some variations in temperature distribution occurred

within all oven types and that control of the smoking and drying rates could only be achieved by rearranging the layers of fish or by adding or removing firewood from the fire. The oven that performed best in terms of cost, capacity, ease of operation, product quality and fuel efficiency was the Chorkor smoker.

From 1988 to 1997, under the Ghana/Netherlands Regional Training and Applied Research Project for Artisanal Fish Processing in Africa, a six-week regional training course was organized each year on artisanal fish processing and extension methods. During these courses, the Chorkor smoker featured prominently. Participants were taught how to construct and use the innovation. It is noteworthy that participants came not only from West African countries but also from eastern and central African countries such as Cameroon, Ethiopia, Eritrea, Ghana, the Gambia, Kenya, Lesotho, Nigeria, Sierra Leone, Tanzania (including Zanzibar), Uganda and Zambia.

Feedback from former course participants showed that they had been able to extend use of the Chorkor smoker to their own countries.

LESSONS LEARNED

Developed for use in Ghana, the Chorkor smoker has been accepted in most western, central and eastern African countries and has been introduced beyond Africa.

Since fish processors were in most cases involved from the beginning, the acceptance and adoption rates of the oven were high from the initial stages.

Introduction of the smoker has indirectly increased the enthusiasm of women fish smokers and led to the development of integrated programmes such as sanitation, environmental education and development **of** infrastructure and banking. These activities have contributed to the socio-economic development of the rural communities concerned. Akplabanya, a fishing village in the Ada district of the Greater Accra region of Ghana, is a good example of a village where the introduction of the Chorkor smoker in **1982** led to improved socio-economic status for the community. Fish processors and fishermen have been introduced to banking with a rural bank in the area and, because of their good financial practices, the processors have gained access to credit, usually in the form of materials such as outboard motors, wire mesh and bowls.

In places where the Chorkor smoker has been introduced, locally available materials are sent to the community and the innovative oven **is** constructed with the participation of the users.

The oven is easy to build, *so* no technical skills are required. Although the innovation is affordable, however, the ever-increasing cost of some construction materials such as ***wawa*** board, wire mesh, nails and plywood is making it impossible for some fish processors to invest in the oven.

The smoker is user-friendly, easy to operate and time-saving, thus alleviating drudgery. It has reduced labour requirements by about 30 percent and firewood use by about the same. It has contributed immensely to the production of high-quality smoked fish, as it can smoke about 200 kg of fresh fish, about ten times the capacity of the traditional cylindrical mud/metal ovens.

Although the advantages of the Chorkor smoker are obvious to the fish processors, some are not able to invest because of a lack of working capital. More money is required to invest in the purchase of fresh fish to fill the Chorkor smoker, since it has greater capacity than the traditional ovens. In addition, most processors do not receive organized credit and recent poor and intermittent fresh fish catches in Ghana have made it difficult for the processors to use the smoker at full capacity. To help solve this problem and reap the benefits of operating at full capacity, a single-unit Chorkor smoker has also been introduced.

The Chorkor smoker has proved a useful innovation in both marine and freshwater fisheries, because it is easily adjusted to local needs and conditions by the processors themselves. In Tema, for example, the clay base has been replaced by refractive bricks obtained from cinders of the Valco bauxite furnace. These bricks are more durable and have better heat retention properties, which further improves fuel efficiency. The depth of the trays is increased in areas where bigger fish, especially freshwater fish, are smoked. The clay base of the oven is also made higher in freshwater settings, in order to avoid charring as a result of oil dripping from the fatty fish into the fire.

Before the smoker was introduced, most of the anchovies landed were sun-dried on the ground, resulting in a poor-quality product that was unsafe for human consumption. With the availability of the oven, anchovy smoking is now widely practised, with a better-quality product that is safer for both human consumption and animal feed production. In fact, smoked anchovy is now being stored for several months for sale during the lean season at a higher market price, thus increasing the income of the processors.

The Ghana/Netherlands regional training project was initiated in 1987 to extend and transfer improved fish preservation technologies, starting from the handling of fish at sea through the various stages of processing, storage and distribution. It aimed to contribute to the reduction **of** post-harvest losses and to enhance the availability of quality fish and fish products for rural populations. To date, in the 14 **pilot** villages used for field demonstrations, 202 women fish processors have received bases, each containing 5 trays, a total of 1 010 trays. As a result of the project, job opportunities have been created and incomes have been generated for rural women. Introduction of the Chorkor smoker has also encouraged younger women to take up fish smoking as a profession.

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