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Guide for developing and using

The FAO-Thiaroye Processing Technique (FTT-Thiaroye)

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The FAO–Thiaroye Processing Technique (FTT–Thiaroye)

by

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Abstract

Owing to its devices that are the ember furnace, the fat collection tray, the indirect smoke generator system and the hot air distributor, the FAO-Thiaroye processing technique (FTT-Thiaroye), focus of this methodological guide, strengthens the functions of existing improved smoking techniques in small-scale fisheries.

Superior and consistent quality and safe products, with a good value for money, and meeting food safety requirements are achieved in (i) complying with technical and sanitary engineering of the facilities to harbor it, (ii) following the instructions provided herewith regarding the design, construction and use of the assembled equipment, (iii) and applying good hygienic and good manufacturing practices. Indeed, the FTT-Thiaroye has the particular merit of overcoming the challenge linked to the polycyclic aromatic hydrocarbons (PAHs) given its feature which mainstreams the relevant code of practice of the Codex Alimentarius (CAC/RCP 68-2009). It further curbs the fuel consumption while reducing the exposure of the fish processor to the smoke and heat.

After a general overview of the comparative advantages of the FTT-Thiaroye, detailed information are provided to any development practitioner or any interested person or entity on the different components/devices, the supply in fuel, how to use and operate the FTT-Thiaroye, and how to care and maintain it.

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Enlightened advice from experts and resource persons from FAO and fisheries institutions of its Members also contributed to making this publication a good information source, useful for serving the cause for which it was conceived. May they find here the expression of our gratitude.

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Abbreviations and acronyms

| | |
|---------------------|--|
| CNFTP | National Training Centre for Fish and Aquaculture Technicians (Centre National de Formation des Techniciens des Pêches et de l'Aquaculture, Senegal) |
| FRI | Food Research Institute (Ghana) |
| FTT-Thiaroye | FAO-Thiaroye Processing Technique |
| NGO | Non-governmental organization |
| PAH | Polycyclic aromatic hydrocarbon |
| USD | United States dollar |



Introduction to processing methods in artisanal fisheries



Traditional drying method

Smoking and drying are important fish processing methods for small-scale fisheries in countries geographically located around the tropics.

These two techniques represent the main and, at times, only ways to supply populations, particularly those far from fishing sites, with fish, which is known to be perishable. This form of supply is even more necessary when poor infrastructure and an inefficient cold chain impede the supply of fresh foodstuffs.

The techniques generate products with an extended shelf-life that can be transported over long distances, providing an opportunity for storage over several months (up to 5–6 months with appropriate monitoring) and enable regular deliveries based on demand. They also help to reduce post-harvest losses very often related to limited fish chilling and/or freezing capacity during bumper harvests.

Moreover, smoked and dried fish provide a wide variety of textures and flavours, resulting in a greater choice for consumers.

Different types of kilns have been used to produce smoked fish. They range from traditional kilns (round mud kilns, barrel-shaped kilns) to improved ones (the multitrack Chorkor, Banda, Altona, cinderblock, etc.). The Cinderblock and Chorkor¹ are the most popular among these improved kilns. The Chorkor is an important result of collaborative research carried out jointly by FAO and the Food Research Institute (FRI) in Ghana. This kiln was introduced in 1969 in West Africa and has since made a significant contribution to the way small-scale fish processors manage their smoking and storage operations.

¹ The Chorkor kiln is named after the village of Chorkor located close to Accra, Ghana, where the smoking of fish is quite prominent. It was developed and introduced in this village in 1969 by the Food Research Institute (FRI) of Ghana in collaboration with the women fish processors of this fishing community. FAO then widely disseminated this modern smoking kiln with the aim of improving the quality of fish smoking, reducing losses at wharves and improving smoking process conditions. The Chorkor kiln is mainly designed for smoking but it is also used for drying and storage of processed, smoked or dried fish.

In comparison with traditional ones, these kilns have a higher energy efficiency and greater capacity; they lead to less exposure of operators to smoke, heat and burns; and they enable to better-quality products to be generated with reduced physical and quality losses because the fish is not blackened, charred or completely lost in the fire.

Regarding drying, the sun is used as an energy source, which thus occurs in the open air. Therefore, development programmes and projects have promoted sun drying on raised racks, following a timid social acceptance and low adoption of solar tents. However, sun drying on raised racks has important limitations in rainy or cloudy weather as drying becomes difficult and sometimes impossible. In addition, drying in the open air exposes the product to contamination by wind, dust, insects, rodents and bird droppings.

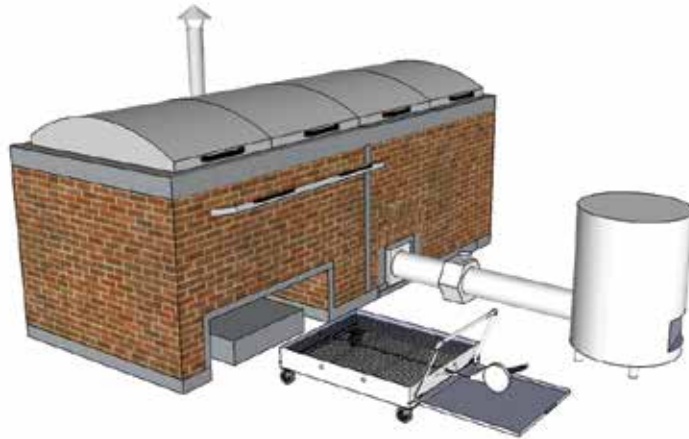
These smoking and drying techniques have some limitations that deserve greater attention in order to significantly improve small-scale fishers' livelihoods and respond effectively to product safety challenges – especially linked to controlling contamination by polycyclic aromatic hydrocarbons (PAHs). A public health hazard, PAHs are generated by the combustion of fossil fuels in gaseous form. Their origin may be environmental (volcanic eruptions, forest/bush fires, diesel engines) or due to human activities (e.g. food preparation, cement industry). Humans are exposed to hydrocarbons by inhalation, ingestion or by skin contact. Several epidemiological studies carried out in the workplace have shown that individuals exposed to benzene and PAHs can develop certain cancers. Food remains the primary mode of contamination for non-smokers. The occurrence of PAHs is intimately linked to the processing conditions of food. In addition, the advances in analytical science and the increasing need for better consumer health protection, be it for the local market or for export, call for necessary changes in artisanal smoking and drying processes to be implemented.

In some African countries, because of abnormally high PAH levels, several detentions have occurred and small-scale units have been suspended from exporting their hot-smoked products to the lucrative market of the European Union (Member Organization).

According to the *Code of practice for the reduction of contamination of food with polycyclic aromatic hydrocarbons (PAH) from smoking and direct drying processes* (CAC / RCP 68-2009) of the Codex Alimentarius (CAC/RCP 68-2009), the formation of PAHs during smoking and direct drying depends on a number of variables, including:

- fuel (wood, diesel, gases, liquid/solid waste and other fuels);
- smoking or drying method (direct or indirect);
- smoke generation process in relation to the temperature of pyrolysis and to airflow in the case of a smoke generator (friction, smouldering, thermostated plates) or in relation to other methods such as direct smoking or regenerated smoke by atomizing smoke condensate (liquid smoke);
- the distance between the food and the heat source;
- position of the food in relation to the heat source;
- fat content of the food and what happens to it during processing;
- duration of smoking and direct drying;
- temperature during smoking and direct drying;
- cleanliness and maintenance of equipment;
- design of the smoking chamber and the equipment used for smoke/air mixture (which influences the smoke density in the smoking chamber).

The need for better control of these factors has prompted the development of the FAO-Thiaroye Processing Technique (FTT-Thiaroye), to ensure that processing operations first comply with food safety requirements, and that they also may be carried out regardless of weather conditions. They can be conducted in any season, thereby strengthening the livelihoods of millions of people such as fishers, processors, traders and ancillary workers engaged in manufacturing the equipment. In addition, the FTT-Thiaroye technique also contributes to safeguarding the environment by using plant materials, which are often bulky for the environment, such as coconut husks and shells or corn cobs, as fuel.



A training institute in Senegal, the National Training Centre for Fisheries and Aquaculture Technicians (CNFTPA), in partnership with FAO, designed and developed the FTT-Thiaroye to address the issues raised. It was designed by building on the strengths of the existing improved kiln models while correcting their shortcomings to come up with accessories that are available locally and suitable for small-scale processing operations. The trials of this technique for smoking inspired the designers in performing further tests to also use it as a mechanical dryer to meet challenges faced by some processors during natural drying of fish.

This system should be perceived and conceived in a broader framework of integrated facilities that meet technical and sanitary requirements recommended in the design and use of fish handling and processing equipment. It is therefore important to stress that the FTT-Thiaroye equipment should ideally be housed under a roof or sheltered structure.

Objectives

This guide aims to provide information on innovations and the new opportunity provided by the FTT-Thiaroye to improve smoking and drying of fishery products in order to raise awareness and facilitate training for wider dissemination of this technique. Its adoption will enable fish processors to meet food safety requirements and to obtain superior and consistent quality and safe products, with good value for money. They will be able to operate at a reasonable cost and will no longer depend on weather conditions to dry their products.

Target groups

 *The target groups for this guide are mainly:*

- a** - trainers and extension workers, including vocational schools and universities; involved in training and capacity building on issues related to the utilization and marketing of fishery products;
- b** - any person or entity (association/group) specializing or working in fish processing, and more specifically in product smoking and drying;
- c** - field staff of UN Agencies, non-governmental organizations (NGOs) and other public sector professionals, as well as managers of projects that are dedicated to better utilization, more effective control of post-harvest losses and the promotion of responsible trade;
- d** - national, regional and international institutions involved in sanitary regulations and mainstreaming codes of practices.

Contents of this guide

This guide does not aim to provide either a detailed description of the advantages, benefits and added value of this new technique, or the technical engineering of the facilities to harbour its equipment.

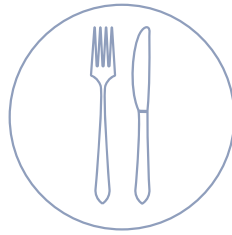
However, it gives a brief overview of these aspects. Its main objective is to serve as an educational and user-friendly tool, to raise awareness and understanding. It will focus on the following points:

- **What the FTT-Thiaroye and its various components/devices are?**
- **How to obtain the various components of the equipment?**
- **How to use the FTT-Thiaroye for each of its functions?**
- **How to maintain the FTT-Thiaroye?**



Overview of the comparative advantages of the FTT-Thiaroye

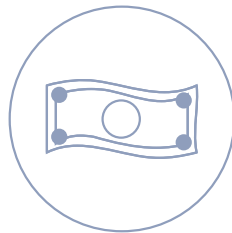
~ The FTT-Thiaroye is an innovative and polyvalent technique with important advantages for each actor along the supply chain. It provides significant benefits to fishers, processors, traders and consumers. These benefits are set out below.



Providing consumers with safe, good-quality food that is good value for money

The FTT-Thiaroye allows the processing of smoked and dried fish products that better meet food safety requirements. This results in a positive endorsement by the competent authority in charge of certifying products placed on the market.

Moreover, consumer confidence is enhanced with superior-quality products that better meet their expectations.



Protecting the businesses of small-scale fish operators (processors and traders)

- The FTT-Thiaroye protects commercial activities of small-scale processors, of whom women make up a significant majority.
- First, it allows easy access to lucrative markets, given the products' good quality and constant and uniform characteristics.
- Second, it offers opportunities to process fisheries products and store them for a long period. This allows for leverage against price fluctuations until optimal market conditions are met.



- The FTT-Thiaroye allows drying and smoking regardless of weather conditions. This results in better control of post-harvest losses, which may exceed 50 percent in some fisheries during the rainy season or on cloudy days.
- In addition, thanks to the FTT-Thiaroye, costs linked to controls, analyses and detentions of products by relevant government agencies are reduced.
- In fact, the standardized processes allow mitigation of the risks of non-compliance. This not only helps to reduce post-harvest losses, but also improves the income of operators.
- Finally, the FTT-Thiaroye provides opportunities for additional revenue with the possibility to process by-products, e.g. fat gathered through the FTT-Thiaroye's fat-collection tray allows manufacturing of soap, or it can be used as cooking or frying oil.



Contributing to ancillary employment through support to small-scale manufacturers of FTT-Thiaroye equipment

Making or constructing the FTT-Thiaroye equipment is achievable at the community level and thus relies on the expertise of local artisans.



Mainstreaming gender concerns

The FTT-Thiaroye contributes to improving the lives of women fish processors because it results in safe smoking conditions and ensures less heat, burn and smoke exposure; this is a major efficiency smoking system criterion for a large majority of operators. Moreover, the FTT-Thiaroye enables time savings in processing, thus allowing processors to attend to other business. This is a significant advantage because, in communities, women must often simultaneously engage in household chores (children, kitchen) while carrying out their fish processing activities.



Contributing to environmental protection by reducing fuel consumption

The FTT-Thiaroye focuses on reducing the amount of wood used as fuel by adding stones and thus decreasing the required amount of coal by about 50 percent. The FTT-Thiaroye also easily adapts to other fuels such as coconut husks and shells, stems or corn cobs and millet, sugar-cane bagasse, and also butane gas. The use of the FTT-Thiaroye means less deforestation and better protection of mangroves, resulting in a positive impact on natural resources. This also allows processors to spend less money for their fuel needs.



1. Equipment common to existing improved kilns

The dual compartment kiln – below is a description of the equipment generally found in existing improved kilns.

1.1 The dual compartment frame for the vibrated kiln

~ What does it look like?



1 - Dual compartment frame (made with cement)



2 - Dual compartment frame (made with bricks)

~ How to make or buy it?

Given that the construction of cinder block and Chorkor kilns, made of mud or brick, is already very well documented², this guide only describes the vibrated kiln (made with firebricks), which has a slightly higher cost but a longer life span. Building stages for the dual compartment vibrated kiln are as follows:

- a - Dig a 20 cm trench and case it with wooden planks. Then position iron bars inside the trench.



3 - Levelling the ground – foundation



4 - Digging a 20 cm trench

² See pp. 21–31 of Ndiaye, O. & Diei-Ouadi, Y. 2009. *De la pirogue à l'étal: équipements améliorés de manutention et de transformation pour la pêche artisanale*. FAO Fisheries and Aquaculture Technical Paper No. 535. Rome, FAO. 65 pp. (also available at www.fao.org/docrep/012/i1139f/i1139f.pdf). Please note that the FTT-Thiaroye equipment has only one fireplace measuring 27 cm in height and 100 cm in width and not of two fireplaces 45 cm by 45 cm as described in the technical paper.



- b** - Cast the foundation with a mixture of 2 bags of cement, 2 wheelbarrow-loads of sand and 2 wheelbarrow-loads of gravel. After a day, the foundation is stripped from its casing.



5 - Iron bars are positioned in the trench. The foundation is then cast

- c** - The set of walls and the compartment partitions are cased and covered with 6 mm diameter iron bars.



6 - Casing

- d** - The lintel at the gates and the chaining to the upper part are well evidenced.

- e** - A 7 cm output ledge coming from the walls is cast at 20 cm from the chaining of the upper part.



7 - Output ledge

- f** - A metal angle edging 30 cm wide and 5.80 cm long is cast onto the upper part of the kiln to allow the lid to rest on this angle edging and thus hermetically close the kiln.
- g** - Two metal anchors, each 1 m long, are inserted 5 cm below the metal angle edging of the cooking rack and 70 cm from the gate of the furnace; these anchors must hold the fat-collection tray.



8 - Fat-collection tray positioned on the metal anchors

- h** - The ducts of the fat collector are inserted into two 30 cm long metal tubes that each have a 5 cm diameter. These tubes are on the back wall of the kiln to facilitate the external flow of grease and exudate out of the collecting tray.



9 - Tubes at the back of the kiln that allow the grease to flow from the tray collecting the fat dripping from the fish into the external buckets



~ What are the technical characteristics and average cost of the vibrated kiln?

| Table 1: Technical characteristics and average cost of the vibrated kiln | | |
|--|---|--------------------------------|
| Characteristics | Specifications | |
| External measurements | Total length (both compartments + partitioning wall) | 280 cm |
| | Width | 130 cm |
| | Height | 120 cm (with 20 cm foundation) |
| Internal measurements of each compartment | Inside length | 100 cm |
| | Inside width | 190 cm |
| | 2 symmetrical compartments, one for cooking and the other for smoking | |
| Thickness of the partitioning wall | 20 cm | |
| Height of the metal anchors / output ledge to hold the metal racks | 70 cm | |
| Metal angle edging to hold the lids for each compartment | Length | 120 cm |
| | Width | 100 cm |
| Opening of the fireplace for cooking compartment | Length | 102 cm |
| | Width | 90 cm |
| | Height | 27 cm |
| Opening of the fireplace for a smoking compartment | 25 x 25 cm | |
| Maximum loading capacity per compartment | 200 kg of fish | |
| Life span | At least 25 years | |
| Average cost | 800 USD | |

~ What materials are used to build the dual compartment cinderblock kiln prototype?

Table 2: Materials used to build the dual compartment cinderblock kiln prototype

| Designation | | Quantity |
|------------------------------|--------|------------------|
| Cement | | 15 bags |
| Iron bars of 10 mm | | 100 kg |
| Iron bars of 8 mm | | 50 kg |
| Rice grains | | 4 m ³ |
| Dune sand | | 4 m ³ |
| Concrete | | 4 m ³ |
| Wire | | 1 kg |
| Casing wood (plywood sheet); | | 4 sheets |
| Metal angle edging | Length | 5,80 mm |
| | Width | 30 mm |
| | | 1 bar |

1.2 Lids

~ What do they look like?

They are used not only to cover the product during smoking and drying but also to protect it afterwards. Where the processor already has a dual compartment kiln, it is important to have FTT-Thiaroye accessories that meet the measurements of this particular kiln.



10 - Fish smoking/drying lids



~ How to make or buy them?

They can be acquired by ordering them from a metalworker. They are made of galvanized steel metal sheets to withstand higher heat and air oxidation, and they are equipped with handles.

~ Improving the lid

This model that can slide is easy to use for a kiln with the following measurements: length 190 cm, width 1 m, height 90 cm. In this case, the height of the lid can be increased and at least three stacked racks (metal anchors are fixed on both sides of the lid allowing easy placing of the racks) may be inserted.

Stacking these racks increases the kiln's volume.



~ What are the technical characteristics and average cost of the kilns lids?

The measurements should correspond to those of the racks and the top openings of the kiln's two compartments. For this prototype, the lid for each compartment measures 120 cm in length and 110 cm in width. The average manufacturing cost is USD80. It has an estimated life span of a minimum of three years.

~ What materials are used to manufacture a lid?

| Designation | | | Quantity |
|------------------------|-----------|--------|---------------|
| Galvanized steel sheet | Thickness | 15 mm | 1 and ½ piece |
| | Length | 2 m | |
| | Width | 1 m | |
| Cornière | Length | 5,80 m | 1 piece |
| | Width | 30 mm | |
| Rustproof liquid | | | ½ kg |

1.3 Racks

~ What do they look like?

The drying/smoking racks are removable and are made of suitable materials to facilitate cleaning, heat resistance, thereby ensuring a long life span.



12 - Smoking rack in galvanized steel with a metal frame



13 - Smoking racks in galvanized steel with a wooden frame

~ How to make or buy them?

Racks with metal frames are made to order by a metalworker, and the wooden ones are manufactured by a carpenter or cabinetmaker. Each rack has two components: the frame (wood or metal) and the mesh (metal).

~ What are the technical characteristics and average cost of the smoking/drying racks?

Smoking and/or drying racks are chosen depending on the type of kiln.

For cinderblock kilns, racks with metal frames and galvanized steel mesh are recommended. Each rack will have the following measurements: 98 cm long, 88 cm wide, 5 cm high materialized by the 30 mm metal angle edging. Two racks (one for each compartment) were manufactured for the vibrated kiln prototype tested in an artisanal processing site. The maximum load of fresh fish per rack may reach 100 kg.

Table 4a: Technical characteristics and average cost of the smoking/drying racks

| Characteristics | Specifications | |
|--|---|---|
| Measurements of the rack with a metal frame and galvanized steel mesh for the cinderblock kiln | Length | 98–100 cm |
| | Width | 88–90 cm |
| | Height | 5 cm materialized by the 30 mm metal angle edging |
| Position of the racks | At the level of the metal angle edging / fixing bracket in the upper part of the kiln | |
| Number of racks per kiln | 2 | |
| Maximum load per rack | 100 kg | |
| Life span | 3 ans | |
| Average cost per rack | USD85 | |



For Chorkor kilns, stackable racks will have wooden frames and galvanized steel mesh and the following measurements: 1 m in length and 80 cm in width. The height of the frame will increase from 7 cm (usual measurement for the Chorkor kiln) to 10 cm by making a 3 cm longitudinal opening to allow the warm air through during drying. The rack is equipped with a 12 cm handle to facilitate its handling. The maximum load per rack may reach 20 kg of fresh product. For efficiency, it is preferable and advisable not to stack more than 10 racks.

Table 4b: Technical characteristics and average cost of the smoking/drying racks (for Chorkor kilns)

| Characteristics | Specifications | |
|---|----------------|--------------------------------------|
| Measurements of the rack with a wooden frame and galvanized steel mesh for the Chorkor kiln | Length | 2 m |
| | Width | 80 cm |
| | Frame height | 10 cm with a 3 cm cut-out for airing |
| Maximum number of racks recommended | 10 | |
| Maximum load per rack | 20 kg | |
| Handle length | 12 cm | |
| Life span | 3 ans | |
| Average cost per rack | USD25 | |

N.B.: The mesh should have a netting size of 1 cm for small species and up to 3 cm for large fish, and the wire diameter should be about 0.7 mm in diameter.

~ What materials are used to manufacture a rack?

Table 5a : Metal rack for the cinderblock prototype

| Materials used to manufacture a rack | Quantity |
|--------------------------------------|------------------------|
| Mesh: Length: 17/20 mm | ½ sheet (2 m x 120 cm) |
| 30 mm metal angle edging | 2 bars |
| Rods for welding | 1 pack |
| Rustproof liquid | ½ kg |

Table 5b : Ventilated rack with wooden frame for stackable drying/smoking racks in the Chorkor kiln

| Materials used to manufacture a rack | Quantity |
|--|----------|
| Plank, beam for the box: Length: 3,5m; Width: 12 cm; Thickness: 5 cm | ½ piece |
| Galvanized steel sheet/ Length: 2 m; Width:1 m | ½ |
| Bracket screws | 1 pack |
| Anti-termite liquid | 1 litre |

2. New components specific to the FTT-Thiaroye and which may be fitted to existing improved kilns

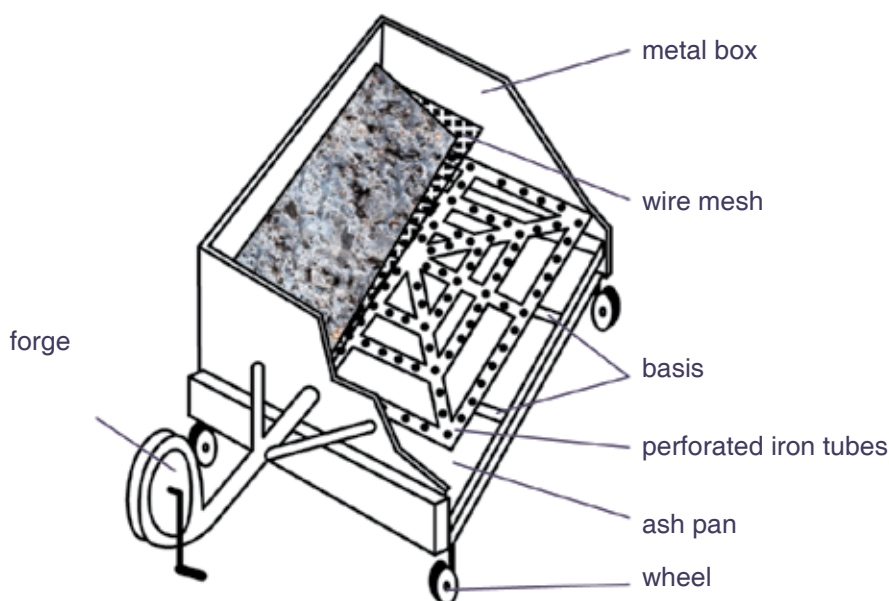
2.1 Ember furnace

~ What does it look like?

The ember furnace is meant to hold the fuel used to cook the fish. Loading it in the fireplace concentrates the heat on the product, reducing the external leakages that might otherwise affect the operator during smoking. This feature also reduces fuel consumption.

The furnace should fit the dimensions of the kiln's gate and it consists mainly of a metal box 26 cm high and 1 m wide. Where the gate is too small, it will have to be enlarged. The furnace is equipped with:

- four (4) wheels to facilitate its movement towards the opening of the kiln;
- cut, perforated iron tubes that are welded to the casing, and which serve as ventilation air pipes;
- a removable ash pan;
- a wire mesh to carry the embers;
- a forge to kindle the fire and send the hot air inside the kiln;
- a detachable pull tab in order to move and/or handle it easily.



14 - Furnace parts





15 - Manufacturing of the metal box



16 - Assembled metal box

Manufacturing the furnace requires a series of steps:



17 - Cutting out the bottom of the box



18 - Cutting out the sheet to dispose of the ashes

a - Manufacture the 26 cm high and 1 m wide metal box from a 1,5 mm thick sheet of galvanized steel.

- b** - Cut out the bottom of the 60 cm × 60 cm ash disposal box
- c** - The cut-out sheet that will be used as an ash container is inserted at the bottom of the box and slides on two iron plates welded on each side of the box.



19 - Ash sheet inserted at the bottom of the box

- d** - Metal tubes are cut out, perforated and soldered onto the box and serve as air ventilation pipes.



20 - Assembling the metal tubes that serve as air ventilation pipes



21 - Metal air tubes welded to the box and topped with a metal grid that will hold the embers

- e** - Install on the box a fanning forge, the wheels to easily handle the furnace, and a metal mesh for the coals.



22 - Fanning forge and wheels that facilitate handling the furnace



~ Improving the furnace

The furnace is equipped with a detachable pull-tab that fits on with a pipe placed on the front of the furnace.



23 - The furnace equipped with a detachable pull-tab

~ What are the technical characteristics and average cost of the furnace?

Table 6: Technical characteristics and average cost of the furnace

| Designation | Specifications | |
|----------------------|----------------------------------|-------|
| Furnace measurements | Length | 98 cm |
| | Width | 88 cm |
| | Height | 26 cm |
| Mesh | Netting | 5 mm |
| | Length | 97 cm |
| | Width | 87 cm |
| Forge | One, equipped with a dynamometer | |
| Life span | 5 years | |
| Average cost | USD200 | |

~ What materials are used to construct the furnace?

Table 7: Materials used to construct the furnace

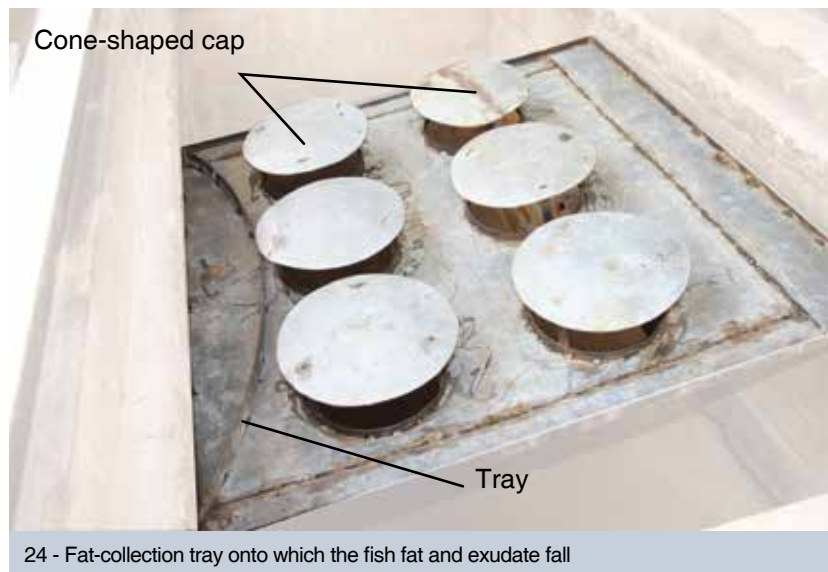
| Designation | Quantity | |
|---|----------|--------|
| Galvanized steel sheet: Thickness: 1,5 mm | 1 sheet | |
| Cornière | Length | 5,80 m |
| | Width | 30 mm |
| Flat iron : 25 mm | 1 piece | |
| Forge | 1 piece | |
| Metal wheels | 4 pieces | |
| Handle | 2 pieces | |

2.2 Fat-collection tray

~ What does it look like?

The fat-collection tray is a system for collecting fat while cooking the fish. It includes:

- A set of holes, each topped with a cone-shaped cap. The holes allow the heat from the stove to reach the fish on the rack, and the cone-shaped cap allows the fat and exudate to drip on the tray instead of falling into the fire and cause a tar deposit on the product.
- The oil and exudate oozing from the fish will fall on a tray that will be slightly tilted so that the oil can drip towards the edge. The oil will be collected in a container placed outside the furnace through the pipes welded at the end edges of the tray.



~ How to make or buy it?

The fat-collection tray can be made to order by a metalworker using the drawing of a prototype and all the technical requirements.

Several steps are required to manufacture the fat-collection tray:

- a - Six 20 cm in diameter holes are made on a 1.5 mm galvanized steel sheet and then a 3 mm diameter iron tube is welded all around each hole.



- b** - Each hole is topped by a cone and is connected at a height of 10 cm to the collector through four 3 mm iron pipes.



27 - Hole topped by a cone

- c** - A rounded iron tube is soldered at 15 cm from the lower part of the collecting tray and to a pipe at each end, allowing the oil and the exudate to drip out.



28 - Rounded iron tube soldered to the lower part of the collecting tray

Improving the fat-collection tray

An opening is made in the kiln and it is fitted out with parallel runners allowing the fat-collection tray to slide and be removed more easily without touching the rack as it is now equipped with two handles. This is a more convenient model.



29 - Fat-collection tray with two handles inserted into the oven

~ What are the technical characteristics and average cost of the fat-collection tray?

The size will vary and must fit the kiln in which it will be placed. The one used in the trials had the following measurements: length 99 cm, width 89 cm and holes with a diameter of 20 cm. A short, thin metal rod will be placed on the circumference of each hole; the rods will be topped by a cap. The fat-collection tray will be slightly tilted and placed at 5 cm from the cooking rack loaded with fish.

| Table 8: Technical characteristics and average cost of the fat-collection tray | | |
|--|----------------|-------|
| Characteristics | Specifications | |
| Fat-collection tray measurements | Length | 99 cm |
| | Width | 89 cm |
| Hole measurement | Diameter | 20 cm |
| Number of holes | 6 | |
| Life span | 5 years | |
| Average cost | USD100 | |

~ What materials are used to manufacture the fat-collection tray?

| Table 9: Materials used to manufacture the fat-collection tray | | |
|--|-----------|--------|
| Designation | Quantity | |
| Galvanized steel sheet: | Length | 2 m |
| | Width | 1 m |
| | Thickness | 1,5 mm |
| 30 mm flat iron | 2 bars | |
| 6 mm iron rod | 1 bar | |



2.3 Indirect smoke generator system

~ What do the different pieces look like?

- **The barrel and the metal pipe**

The generator consists of a metal barrel welded to a metal tube that is about 1.5 m long and 30 cm in diameter. The metal tube can be shaped into a spiral or circular tube depending on the available space.



30 - Indirect smoke generator



31 - Metal tube shaped into a spiral

- **The filter system**

The system includes a metal casing in which the filter is inserted. All of these are then inserted into a metal housing.



32 - The metal casing



33 - Inserting the metal casing with the filter into the metal housing

~ How to manufacture or acquire them?

- **The barrel and the metal pipe**

They may be purchased or ordered from a local metalworker. The metal barrel may also be a water tank that is no longer used.

Manufacturing the smoke generator system requires a number of steps:

- a - Shaping the metal sheet into a circle to first obtain a barrel. A first rectangular hole is cut out at the base of the barrel, and will be used as an aperture to light the fuel used for smoking. A lid is also manufactured with a metal sheet; this lid will have a

round shape and a handle and will be used to cover the barrel and retain the hot smoke produced by the fuel while burning.

- b** - Shaping the metal sheet into a circle to obtain a tube. A second hole with the same diameter as the tube is cut out diametrically opposite to the first hole. The tube is inserted into the hole and welded. Then, a flat piece of iron is welded at the end of the tube.



34 - Shaping the metal sheet into a cylinder to manufacture the barrel



35 - Assembling the barrel and the tube

- c** - Manufacturing another tube with one of the two ends fitting the gate of the smoking compartment, and the other fitting the tube linking the generator to the metal housing. A flat piece of iron is welded at this end.



36 - The tube that will be fitted onto the gate of the smoking compartment

- **The filter system**

A metalworker can be asked to manufacture the metal housing suitable to the prototype metal barrel with all the technical requirements. The housing is fitted between the two tube ends (the housing is welded to the flat pieces of iron on each end of the two tube segments: the one coming from the barrel and the one coming from the gate of the smoking compartment). This housing is made of two wide half rings that can be dismantled. A small hole is made on the upper half-ring resting (this hole, in the shape of a funnel, will be used to pour water to humidify the filter, if needed). The bottom half-ring will allow the humidifying water containing tar to flow out and be collected.

A metalworker can also make the rectangular casing, which will fit into the housing. The sponge of plant origin (loofah) used as a filter is placed inside the casing.



37 - Filter

Manufacturing the circular or rectangular filter housing is done using a metal sheet, and then the casing (circular or rectangular, depending on the housing's shape) is manufactured using a 6 mm diameter iron bar.



38 - Fitting the metal casing containing the filter into the indirect smoking system

The fine mesh sponge of plant origin (loofah) can be purchased on the local market or made by the processor.

~ What are the technical characteristics and average cost of the indirect smoke generator system?

| Table 10: Technical characteristics and average cost of the indirect smoke generator system | | |
|---|----------------|-------|
| Characteristics | Specifications | |
| Metal barrel measurements | Height | 70 cm |
| | Diameter | 50 cm |
| Barrel door | Longeur | 25 cm |
| | Width | 25 cm |
| Whole metal tubes | Total length | 1,50m |
| Tube from barrel to filter casing | Length | 80 cm |
| | Diameter | 25 cm |
| Tube from filter casing to the kiln's smoking compartment gate | Length | 70 cm |
| | Diameter | 25 cm |
| Metal housing | Length | 45 cm |
| | Diameter | 40 cm |
| | Epaisseur | 8 cm |
| Filter casing | Length | 40 cm |
| | Diameter | 30 cm |
| Filter: food grade sponge of plant origin (loofah) | Length | 35 cm |
| | Width | 35 cm |
| Life span | 5 years | |
| Average cost | USD260 | |

~ What materials are used to manufacture the indirect smoke generator system?

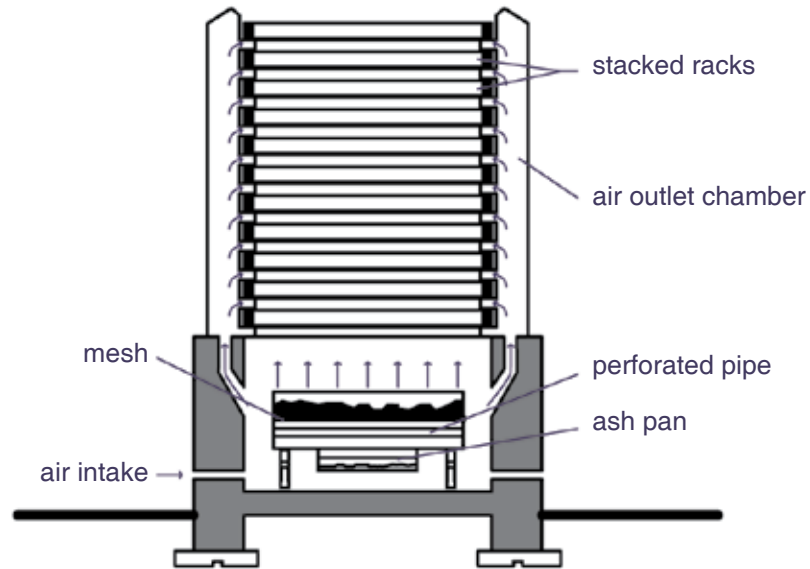
| Table 11: Materials used to manufacture the indirect smoke generator system | | |
|---|-----------|------|
| Designation | Quantity | |
| Galvanized steel sheet | Length | 2 m |
| | Width | 1 m |
| | Thickness | 2 mm |
| Flat iron | 2 pieces | |
| 6 mm metal rod | 1 rod | |
| Rustproof liquid | 1 can | |
| Filter casing hook | 1 | |
| Screws | 6 | |
| Sponge of plant origin (loofah) | 10 | |



2.4 Hot-air distributor

~ What does it look like?

This system is composed of two metal boxes. Inside each of these, horizontal fins match the number of drying racks and perfectly fit them. The drying racks are stacked and arranged vertically.



39 - Drawing of the hot-air distributor

A metal pipe connects the furnace to the air distribution box to facilitate the air flow. The hot air can thus circulate on the racks using the furnace's forge.



40 - Two metal boxes with 4 racks

~ How to make or buy it?

A metalworker can be contacted to manufacture the hot-air distributor according to the prototype metal barrel with all the technical requirements.

Several steps are required to manufacture the hot-air distributor:



41 - Using a galvanized steel sheet to make the air outlet chambers



42 - Incisions/air outlets forming the fins

- a - The two air outlet boxes are made from galvanized steel sheets.
- b - Incisions/air outlets forming fins are made on the two boxes, each one at the same height as the rack frames; their number will match the number of trays used by the operator. A flat iron pipe is welded to each fin and supports the ventilated rack.
- c - A metal lid is used to connect the two chambers in order to store the trays easily and hold them together in a drawer fashion.



43 - Metal lid connecting the two chambers



~ What are the technical characteristics and average cost of the indirect smoke generator system?

The hot-air distributor or “air blower” has the same height as all the racks stacked together and the same width as the wall of the compartments (between 30 and 40 cm). It is made up internally of fins like those of aero-evaporators, enabling the hot air to circulate over each rack. As for the aerated rack’s frame, its height is increased from 7 cm (measurement for the Chorkor) to 10 cm (for the vibrated kiln described in Section 1), and a longitudinal opening is made at a level of 3 cm to allow the warm air through during drying. The size, cost and life span are similar to those of the stacked racks for the relevant kilns with stackable racks.

| Table 12: Technical characteristics and average cost of the indirect smoke generator system | | |
|---|----------------|-------|
| Characteristics | Specifications | |
| Hot-air distributor measurements after fixing the chambers and lid | Height | 1 m |
| | Width | 82 cm |
| | Height | 55 cm |
| Chamber measurements | Longeur | 80 cm |
| | Width | 10 cm |
| Chamber measurements Measurements for ventilation | Length | 75 cm |
| | Width | 8 cm |
| Cut out height for 75 cm x 8 cm to house and air the drying/smoking racks | | |
| Number of boxes | 2 | |
| Number of fins | 5 | |
| Life span | 3 years | |
| Average cost | USD95 | |

~ What materials are used to manufacture the hot-air distributor?

| Table 13: Materials used to manufacture the hot-air distributor | | | |
|---|-----------|-------|----------|
| Designation | | | Quantity |
| Galvanized steel sheet: | Length | 2 m | 1 sheet |
| | Width | 1 m | |
| | Thickness | 15 mm | |
| Flat iron | Length | 4 m | 2 bars |
| | Thickness | 30 mm | |
| Screws | | | 8 |

3. Supply/purchase of fuel

Fuel recommendations

For smoking fish products, wood is generally used. However, agricultural biomass such as bagasse (plant material derived from sugar cane), corn cobs, millet or rice stalks and coconut husks or shells can also be used as fuel.

The choice of fuel is an important aspect to consider in order to avoid potential food contamination. For example, food contamination by PAHs differs depending on whether wood, stalks or hay are used. Oilseed contamination with PAHs is higher when coconut husks are used, instead of coconut shells, which are less rich in lignin.

Wood species used also influence the formation of PAHs. Thus, it is recommended that the potential of PAH formation for each species of wood or plant material be evaluated before using it for smoking. Moreover, it is preferable to use non-resinous wood. Comparative tests between dimb (*Cordyla pinnata*) and sheoak (*Casuarina equisetifolia*) showed that the latter generates fewer PAHs.

The use of fuels other than wood and plant material for smoking food is to be prohibited. Fuels such as diesel, rubber (including tyres) or waste oil should never be used even as a partial component, as they can significantly increase PAHs.

Wood treated with chemicals for preserving, waterproofing, fireproofing, etc. should not be used during smoking or producing condensed smoke. These treatments may cause food spoilage and introduce other contaminants such as dioxin from wood treated with pentachlorophenol³.

How to obtain/purchase fuel?

Biomass fuels from agricultural waste will be collected in agriculture zones as they are readily available and abundant there.

In order to control the generation of PAHs, it is essential to have a thorough knowledge of the toxicity of the components of the different fuels.

3 Pentachlorophenol is a fungicide that has proved effective for the treatment of wood and the bleaching of paper pulp as it reduces the darkening caused by fungi. Given how harmful the product is to people and the environment, the uses of its compounds are heavily regulated.





44 - Corn cobs



45 - Rice hay



46 - Millet hay



47 - Peanut shells



48 - Coconut shells



49 - Coal



50 - Coconut husks



51 - Cordyla pinnata (dimb)



52 - Heat retention stones in clay



53 - Syporex

Table 14: Types and characteristics of fuels that have been tested with the FTT-Thiaroye

| Fuel | What is it? | How to obtain it | Estimated cost | Toxicity |
|--------------------------------|---|--|---|--------------------|
| Charcoal | Comes from the combustion of wood in the absence of oxygen | Purchase from local seller or self-manufactured | USD0,4/kg | ● Highly advised |
| Charcoal + stones | Stones (small stones with heat retention properties such as aerated concrete – syporex) which may be used several times | Local charcoal provider Furnace or censer vendors may sell the stones | USD0,4/kg for charcoal and USD0,5/kg for the aerated concrete | ● Highly advised |
| Coconut shells | Woody timber, gives more flame than coconut husks, no toxicity* was found | Collection/purchase | USD2 per 20 kg bag | ● Highly advised |
| Coconut husks | Woody timber, no toxicity was found | Collection/purchase | USD2 per 20 kg bag | ● Use with caution |
| Rice hay | Non-wood fibres, devoid of colour pigments. Research results have not shown any toxicity. | Collection/purchase | USD3 per 20 kg bag | ● Highly advised |
| Millet stalk and hay | Non-wood fibre, roughage for ruminants as they are rich in dry matter, cellulose and energy | Collection/purchase | USD3 per 20 kg bag | ● Highly advised |
| Filao wood | Resinous* hardwood | Collection/purchase | USD0,2/kg | ● Use with caution |
| Dimb wood | Non-timber hardwood – gives high flame | Collection/purchase | USD0,2/kg | ● Avoid |
| Corn cob and corn straw | Non-wood fibber, rich in xanthophyll pigments** (17 mg/kg dry matter) widely available and very effective for the golden colour desired by many consumers in smoked products. Toxicity found in the straw could be related to its high content of phenolic acids*** active even at low concentrations | Collection/purchase | USD3 per 20 kg bag | ● Use with caution |
| Butane gas | Butane gas cylinder | Purchase | USD8 per 6 kg cylinder | ● Use with caution |

* Resinous wood: qualified as such because the sap produces resin or gum.

** Xanthophyll pigments: pigments that make plant organs yellow

*** Phenolic acids: an organic compound having at least one carboxylic function and one phenolic hydroxyl.

Note: Using recycled wood (treated and painted) is not recommended as it has toxic effects.



~ What is the ratio by quantity of fish to be processed?

| Table 15: Ratio by quantity of fish to be processed | |
|---|--|
| Fuel | Ratio (fuel quantity per 1 kg of fresh fish) |
| Charcoal | 0,4/1 |
| Charcoal + pebbles | 0,25/1 |
| Coconut shells | 0,8/1 |
| Coconut husks | 1,1/1 |
| Rice hay | 5/1 |
| Millet stalks and hay | 5/1 |
| Dimb wood | 0,8/1 |
| Filao wood | 0,8/1 |
| Corn cobs and straw | 3/1 |
| Butane gas | 0.25 m ³ gas for 10 kg of fish |

4. How to use and operate the FTT-Thiaroye

Several operations can be carried out thanks to the FTT-Thiaroye: 1) producing smoked fish products; 2) drying fish products; 3) storing smoked/dried fish products; 4) (re)smoking/ (re)drying fish products that have already been processed.

~ Using the FTT-Thiaroye to produce smoked fish products

4.1 Cooking process

The fat and exudate collection tray is placed below the rack covered with previously pretreated fish. The fish needs to be of good quality in order to generate a good-quality finished product. All the different operations, from receiving the fish to the finished product, should be carried out under the best food safety and hygiene conditions.



54 - Fat-collection tray



55 - Fat-collection tray positioned below the rack loaded with fish

The coal or the relevant recommended material used as fuel is placed in the furnace. It is fanned with the forge to obtain red embers and then the furnace is pushed into the kiln. The furnace is used as a gate at the same time during the cooking.

At the beginning of the process, during the first 30 minutes of cooking, a reduced amount of embers is to be used (with the furnace being only half full), thus preventing the product from developing a superficial crust. This step is actually the pre-cooking.



56 - Charcoal placed on the furnace



57 - Red hot coals placed on the furnace, which is inserted into the oven



The fish is turned over from time to time to prevent it from sticking on the racks. When using a kiln with stackable racks, the racks are regularly interchanged, especially at the beginning of cooking.

The temperature is increased progressively for cooking by filling up the furnace with red embers and fanning the embers with the forge. When the embers are no longer as hot and the fuel is almost consumed, the furnace is removed and fuel added, the embers fanned and the furnace is then put back in the kiln compartment. To save time, small traditional kilns with burning embers can be kept aside, and these coals can subsequently be transferred into the large FTT-Thiaroye furnace. However, it is essential to ensure the safety of children that may be at the processing site. The cooking time depends on the size and thickness of the product and also on the number of stacked racks.



58 - Turning the fish over to prevent them from sticking on the racks



59 - Switching the trays around during the cooking phase

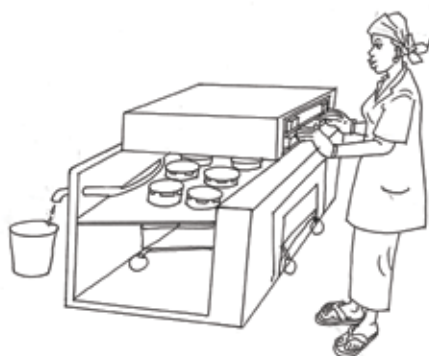
Smaller species (carp) will require up to 4 hours and large fish (catfish, tuna) up to 8 hours to produce a good and uniformly cooked product.

When using the Chorkor kiln, the stacked racks need to be interchanged every 45 minutes to obtain a homogeneous cooking within 6–8 hours.

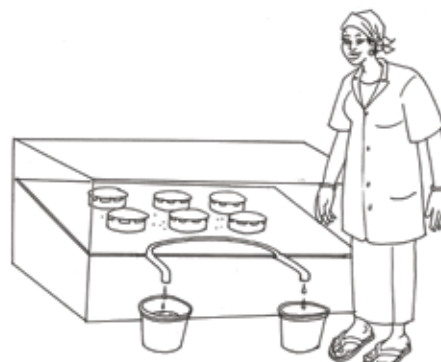
At the end of the cooking, increase the temperature by adding coals to significantly reduce the final moisture content. The easy access to air during this step will allow red embers to be obtained, and the chamber is closed to concentrate all the heat in the smoker. When the processor uses stackable racks, the hot-air distributor system should be fitted onto the compartment so that, when stoking the forge, hot air can be circulated around all the racks, regardless of their position.

Neither flame nor smoke release should be detected during the cooking of the fish. The ideal would be to respect the “zero flame and zero smoke” concept.

The oil and exudate from the fish fall on the tray. The exudate sticks to the tray and dries while the oil oozes and flows through the pipe welded at the end of the tray to be then collected in a container placed at the back of the kiln.



60 - Oil oozing and flowing through the pipe



61 - Collecting oil in containers placed at the back of the kiln

After the first hour of cooking, the fat collector may be full of exudate and crust; it should be cleaned to ensure that it does not produce smoke and flames, which would lead to an increase in PAHs.

The tray has to be cleaned each time fat exudate and crust deposits are significant, as is often the case with fatty fish.



62 - Fat and exudate deposits on the tray



63 - Cleaning the tray of fat and exudate crust deposits

The furnace and the ash pan have to be removed and emptied. Then embers are added to finish the cooking.



64 - Ash pan removed from the furnace to be emptied

After cooking, the fish should be carefully collected and stored in a ventilated room, thus protecting it from the risks of contamination and spoilage. If the amount of cooked fish is sufficient, the smoking step should take place right after the cooking.



65 - Cooked fish.



4.2 Indirect smoking

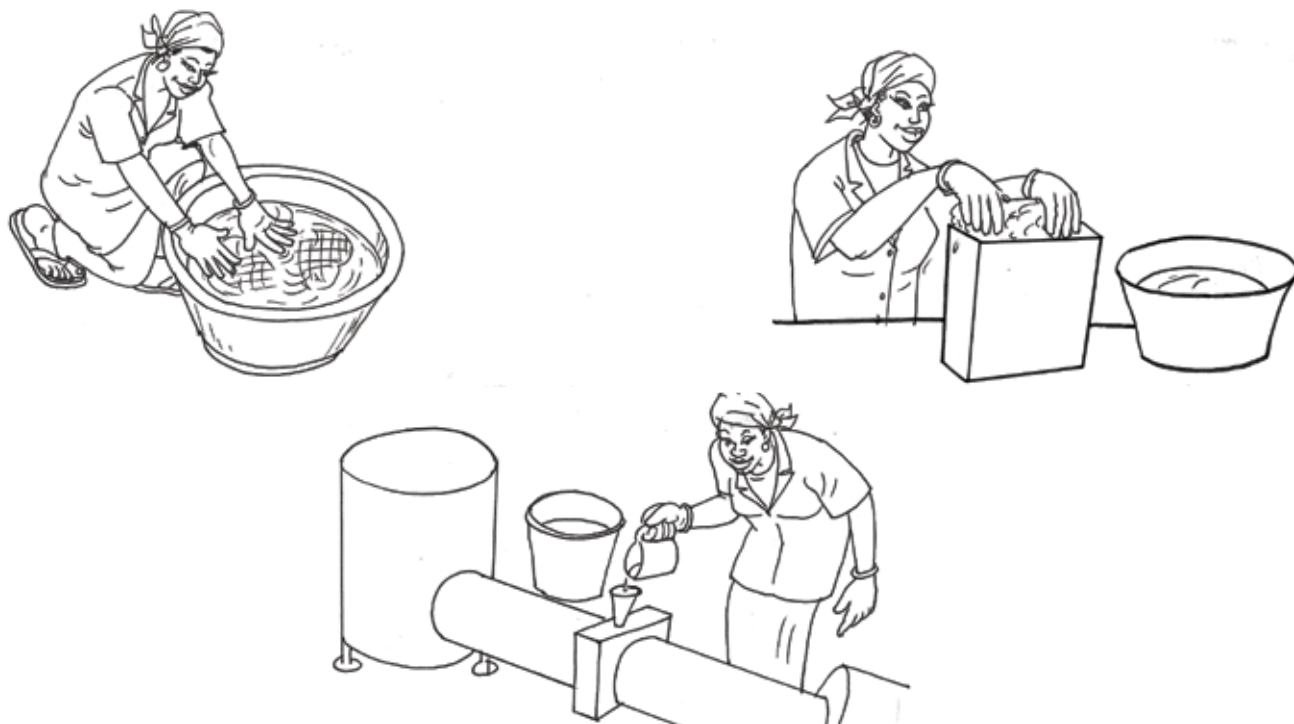
The kiln's second compartment is used for indirect smoking. When stacked, the racks loaded with cooked fish are transferred from the cooking compartment to the smoking compartment. The same procedure is performed in the case of a single rack kiln, such as the cinderblock, but in this case the rack stays in place and the fish is collected and transferred from the cooking compartment to the smoking compartment.



66 - Smoked fish with the FTT-Thiaroye and rack transferred from the cooking compartment to the smoking compartment

The filter retains the acidic tar that otherwise would give smoked fish a blackish colour on the surface and undesirable flavour, signs of potential contamination by toxic residues such as PAHs (as shown by the colour of the sponge of plant origin after smoking). Before its use, the sponge of plant origin (loofah) is moistened with water and laid onto the filter casing, which is then inserted into the metal housing.

To start smoking, the barrel of the smoke generator is loaded with slightly moistened fuel (pieces of coconut husks, millet straw, corn, etc.).



67 - Humidifying and inserting the filter into the metal housing

Humidifying (16–20 percent) the fuel is desirable to avoid flames from forming and to give good flavour to the product. The smoke is purified and cooled by the smoke generator located 1,5 m from the smoking chamber (heat loss depends on the distance). The processors then light the fire, and close the door of the barrel.



68 - Humidifying the fuel and inserting it in the smoke generator barrel

Within an hour of smoking at a temperature between 30 and 34 °C, the smoked product will have a nice shiny appearance, a firm texture, and a characteristic smell. The skin fits tightly, with a golden colour and a pleasant taste. The technical data related to the smoking process with the FTT-Thiaroye (indirect cooking and smoking) are summarized in Table 16 below.



69 - Smoked fish with a golden colour

One should beware of some finished products on the market that have a dark colour, with loosely adherent skin, a hard texture and a bitter taste. They have a lower quality and are less appreciated than those smoked with the FTT-Thiaroye. This is correlated with the smoking method (often this is the result of the incomplete combustion of wood, and smoke laden with harmful particles such as tar).



70 - Lower-quality smoked fish



Table 16: Technical data related to the smoking process with the FTT-Thiaroye

| Parameters | Charcoal | Charcoal + pebbles | Coconut shells | Coconut husks | Rice hay |
|--|------------------|--------------------|-----------------------------|-----------------------------|---|
| Cooking system | Full combustion | Full combustion | Incomplete combustion | Incomplete combustion | Incomplete combustion |
| Heat distribution | Uniform | Uniform | More or less uniform | More or less uniform | Uneven |
| Cooking temperature | 85° C | 90° C | 85° C | 80° C | 85° C |
| Smoking temperature | 30–40° C | 30–40° C | 30–40° C | 30–40° C | 30–40° C |
| Cooking time | 4h45 | 4h | 4h30 | 5h | 5h |
| Cooking & smoking time | 7h35 | 5h30 | 6h | 6h35 | 6h |
| % of water loss in fish | 53,85 | 54,89 | 54,01 | 44 | 43,04 |
| Texture | Dry | Dry | Dry | Slightly soft | Slightly soft |
| Maximum amount of oil recovered (ml) per 20 kg of fish (depending on fat content) | 500 | 500 | 250 | 300 | 200 |
| Control of the operation | Easy | Easy | Somewhat easy, lower flames | Somewhat easy, lower flames | Difficult given denser smoke and flames |
| Smoked fish quality | Most appreciated | Most appreciated | Appreciated | Appreciated | Little appreciated |

with different types of fuel

| Millet stalk and hay | Corn cob and corn straw | Filao wood | Dimb wood | Butane |
|---|-----------------------------|---|---|---------------|
| Incomplete combustion | Incomplete combustion | Incomplete combustion | Incomplete combustion | Blue flame |
| Uneven | More or less uniform | Uneven | Uneven | Uniform |
| 85° C | 85° C | 85° C | 85° C | 90° C |
| 30-40° C | 30-40° C | 30-40° C | 30-40° C | 30-40° C |
| 5h | 4h45 | 4h30 | 4h30 | 4h30 |
| 6h | 6h | 6h05 | 6h05 | 6h |
| 42,34 | 43,91 | 45 | 46 | 47,5 |
| Slightly soft | Slightly soft | Slightly soft | Slightly soft | Slightly soft |
| 200 | 200 | 400 | 300 | 300 |
| Difficult given denser smoke and flames | Somewhat easy, lower flames | Difficult given denser smoke and flames | Difficult given denser smoke and flames | Easy |
| Little appreciated | Appreciated | Little appreciated | Unappreciated | Appreciated |



4.4 Using the FTT-Thiaroye to dry fish products

Where the FTT-Thiaroye is used to produce dried fish, the drying process is conducted in the same way as the cooking phase of the smoking process but with specific steps.

The whole operation takes place in a single compartment (the one used for cooking). The smoking compartment is not used (unless there is another batch of racks and a furnace adaptable to that compartment); similarly, the indirect smoke generator system is not needed. The processing consists of a single step: drying while avoiding cooking the fish.

The operation entails laying out the product to be dried on a rack (or stacked racks) installed in the hot-air distributor and placed onto the kiln. A furnace, equipped with a forge that increases the temperature and the cooking chamber's air mass, heats the drying air.



71 - Fish laid out on the rack for drying

Thanks to the forge, the hot air circulates over the fish drying on stacked racks in the same way as when cooking with stacked racks, the only difference being that the ventilation is more regular for drying.

The time and temperature parameters in the chamber must be well controlled to avoid cooking the fish.



72 - Fish drying in the coal kiln in three hours

Thus, in the case of drying, the quantity of charcoal or any other fuel is very small. The product should be placed well away from the coals and the temperature should be controlled to prevent, first, the product from being cooked and, second, a surface crust developing. This step takes about one hour.

After this phase, the products are turned over so that the drying may be homogeneous and the amount of embers is increased so as to raise the temperature to about 60 °C and the relative humidity to between 60 and 70 percent, thus accelerating the process of drying. The various technical data relating to the drying operation when using charcoal are summarized in Table 17 below.

Natural drying performed in winter took two days while the one carried out with the FTT-Thiaroye and coal took only two hours for shrimp and four to five hours for large fish for an amount equivalent to 50 kg each time. The final product is completely dry, with an attractive shine. This process provides the opportunity to dry large quantities of product without being subject to weather conditions.

Table 17: Technical data related to the drying process when using charcoal

| Technical data | Charcoal |
|--|--|
| Temperature at the beginning of the drying process | 70° C |
| Relative humidity | 70 % |
| Air distribution | More or less uniform |
| Drying time | From 1.5 to 2 h for small species, 3–4 hours for medium sizes, and 4–5 hours for large species |
| % of water loss | 60 % |
| Number of production sessions | 5 sessions for small and 3 sessions for medium size (daily average) |



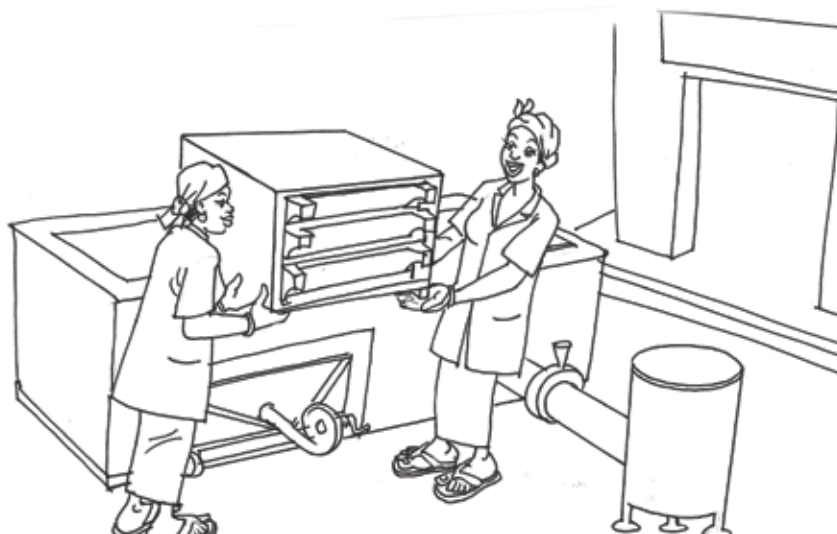
4.5 Using the FTT-Thiaroye to store smoked/dried fish products



73 - Avoid storing fish on the floor

Proper storage helps to maintain the marketability and safety of the product throughout its life span. Storage on the ground is a factor in contamination and product loss.

It is advisable to store food on pallets or stow it on trellis shelves, or pack it in baskets, straw mats, burlap bags or on racks. These should be housed in a shed (for protection from adverse weather).



74 - Side panels that serve as a storage chamber

As for the Chorkor, where stacked trays loaded with processed fish are covered, the FTT-Thiaroye, thanks to some of the air distributor's components, is an ideal storage room or warehouse for smoked or dried fish. Indeed, the side panels of the distributor serve as a storage chamber; the stacked racks serve as the pallets on which the dried/smoked fish has been laid out.

4.6 Using the FTT-Thiaroye to smoke/dry again fish products that have already been smoked/dried

The FTT-Thiaroye works perfectly to (re)smoke and (re)dry fish or other stored products to extend their shelf-life. This operation with the FTT-Thiaroye is identical to smoking/drying. The only parameter that changes is the time/temperature factor, the temperature being much lower in this case.



5. Care and maintenance for the FTT-Thiaroye

5.1 What maintenance needs to be done after processing the fish products?

A better shelf-life and good quality of end product depend on properly maintaining the equipment during and after its use. Yet too often, the equipment is neglected in traditional processing centres.

Daily maintenance for the FTT-Thiaroye (kiln, cover, rack, furnace) entails cleaning inside and around the kilns and removing the ashes and the waste stuck on the lids and on the mesh of the removable racks.

The following operations are also necessary:

- Remove the smoke generator, clean it with soapy water and then let it dry.
- Remove the collector containing the mixture of water and exudate located below the metal housing, empty it and put it back into place.
- Remove the housing and the filter loaded with tar from the smoke and clean it thoroughly.
- Change the sponge of plant origin (loofah) / filter before each new session, while the used one is washed and left to dry.
- Remove the fat-collecting tray, and clean the dried exudate and the grease ducts of the tray, and drain the pipe.

During the low-production or seasonal rest period, metal accessories should be protected against rust by keeping them away from rain and moisture and coating the mesh regularly with vegetable oil. If rust appears on the metal parts, they will have to be scraped and repainted with two layers of rustproofing liquid and one layer of food paint. Damaged equipment must be repaired.



Table 18: Tips for care and maintenance







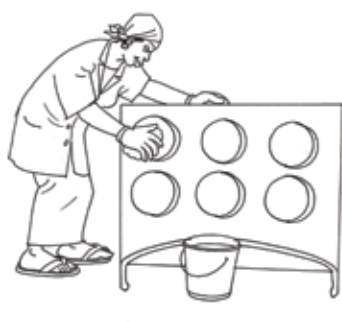

| Accessories | Components | Maintenance between sessions | When is the cleaning carried out? |
|---------------------------------|----------------|--|-----------------------------------|
| | The kiln frame | <p>Remove all the accessories and clean the inside and the surroundings.</p>  | After each day of production |
| Double compartment kiln | The lids | <p>Open, clean with soapy water, rinse and let dry</p>  | After each day of production |
| | The racks | <p>Clean with soapy water, rinse and let dry</p>  | After each day of production |
| The square container or furnace | | <p>Take out the furnace to remove the ashes and put it back in its functioning position</p>  | After each day of production |
| The indirect smoke generator | | <p>a) Open the barrel (both the top and the lateral opening for the fuel)</p>  <p>b) Remove the ashes of the fuel consumed after the smoking c) Close the openings</p> | After each day of production |

Table 18: Tips for care and maintenance

| Accessories | Components | Maintenance between sessions | When is the cleaning carried out? |
|---|---|--|--|
| Take out the fat collector to clean the dried exudate | | | |
| The fat-collecting system | The tray |  | Every time there is a lot of crust deposit |
| | The tray's fat collector. | Carefully clean the tray's fat ducts | |
|  | | | |
| The hot-air distributor and its racks | a) Disassemble the different pieces of the air distributor and clean the fins and the lid | | After each day of production |
| |  | | |
| b) Carefully clean the racks | | | |

5.2 Daily maintenance and care

For regular care and maintenance of the equipment and accessories, a cleaning and disinfection programme should be established and carried out after using the kiln. After cleaning, the material should only be stored once it is completely dry in order to prevent rust forming on the galvanized steel.

Monthly/yearly maintenance and care

During the low-production or seasonal rest period, metal accessories need to be protected against rust by keeping them away from adverse weather, such as rain and sun.

The mesh and the fins need to be coated regularly with vegetable oil. If rust appears on the metal parts, they will have to be cleaned and repainted with two layers of rustproofing liquid and one layer of food-grade paint at least once a year.



6. Conclusion

To support the sustainable development of artisanal fisheries and aquaculture in Member States, FAO is actively involved in applied research work to improve processing operations. The Chorkor kiln perfectly illustrates its cooperative efforts with fisheries institutions in developing countries.

This was started with Ghana's Food Research Institute, which revolutionized fish smoking in the tropics with the Chorkor kiln.

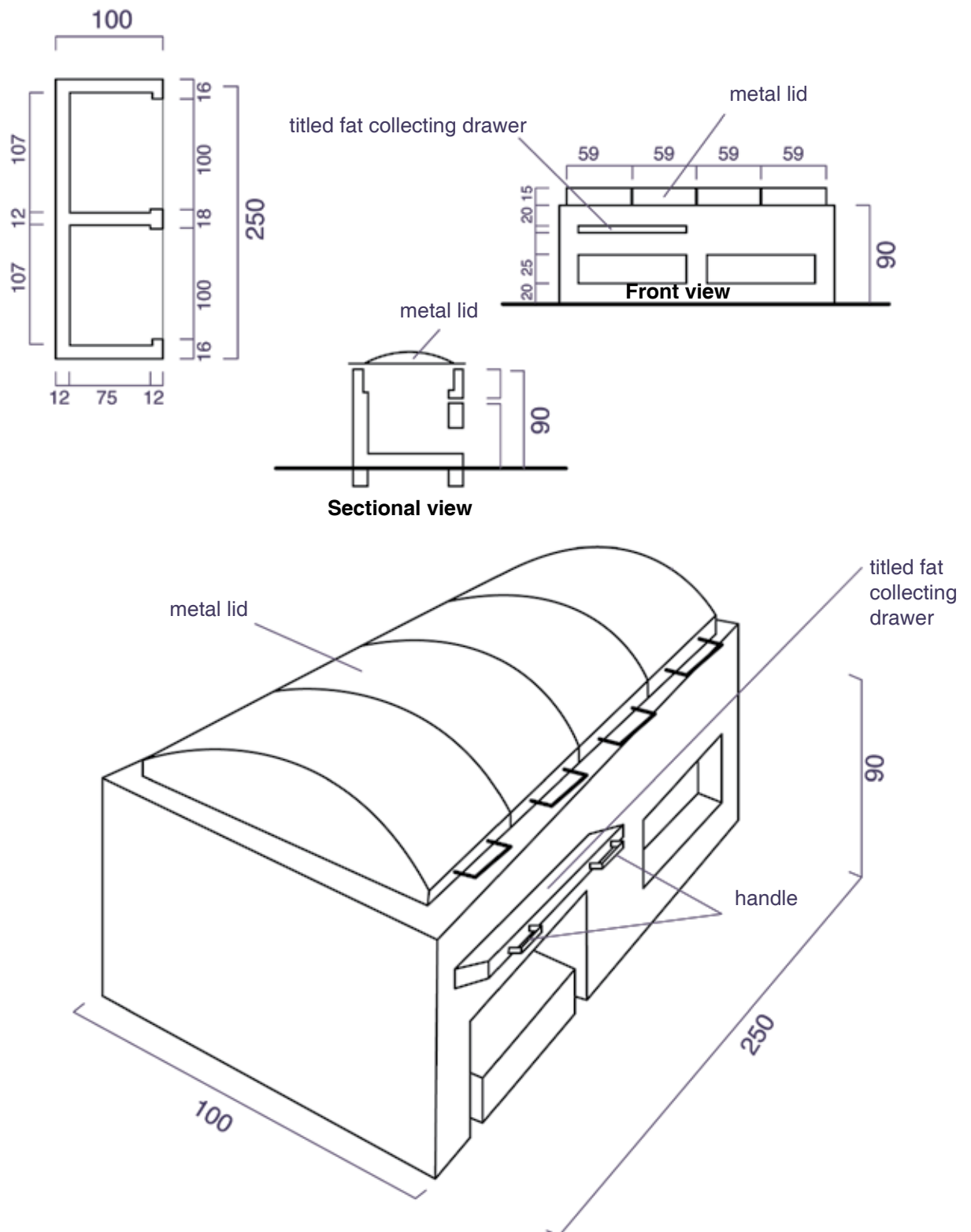
The FTT-Thiaroye is an innovation introduced by Senegal's National Training Centre for Fish and Aquaculture Technicians that further strengthens these efforts. It will contribute to the objective of improving not only the safety of products, but also safeguarding the welfare and livelihoods of millions of people involved in fisheries and aquaculture who supply local and cross-border markets with smoked and dried products.

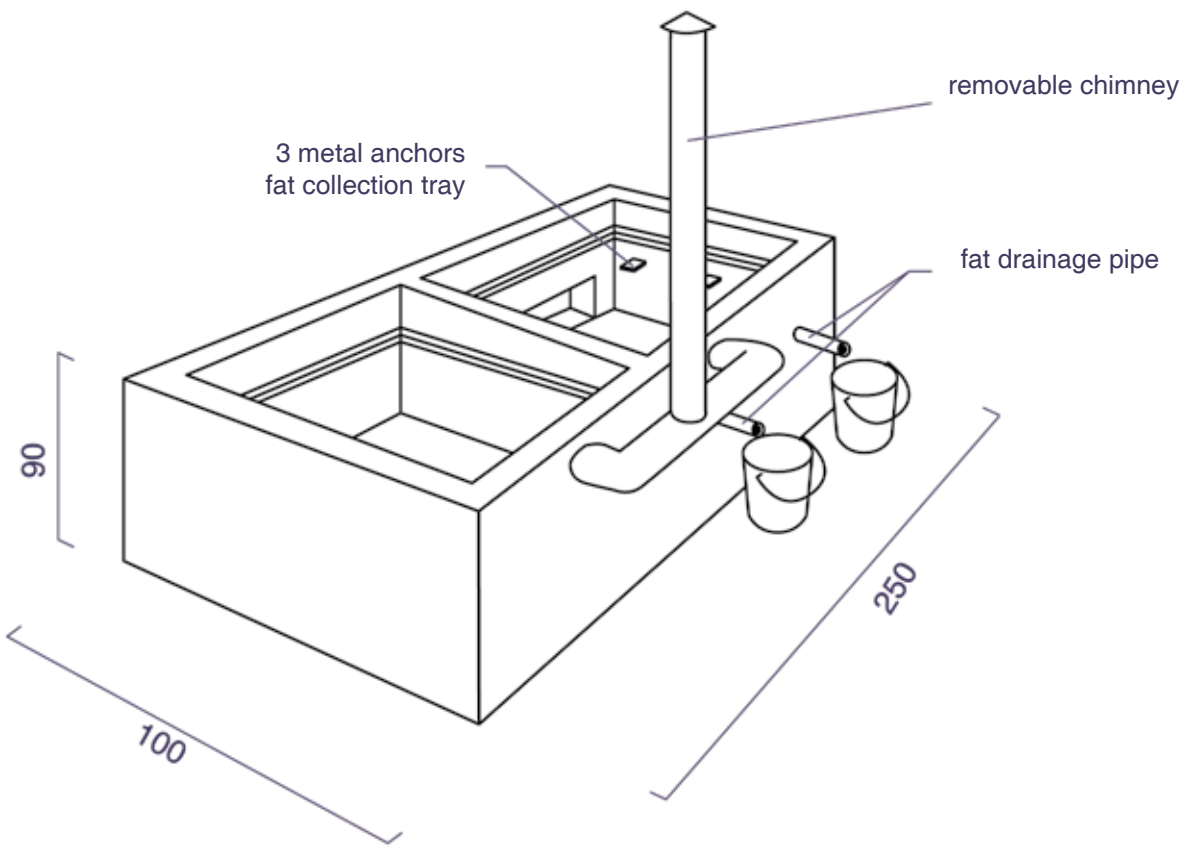


7. Annex

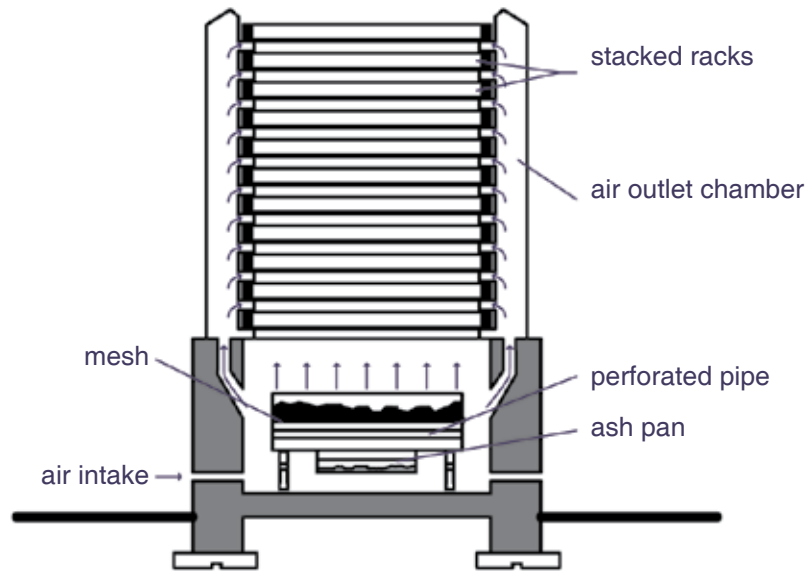
~ Specifications of different kilns (cinderblock, Chokor, Altona)

7.1 Cinderblock specifications





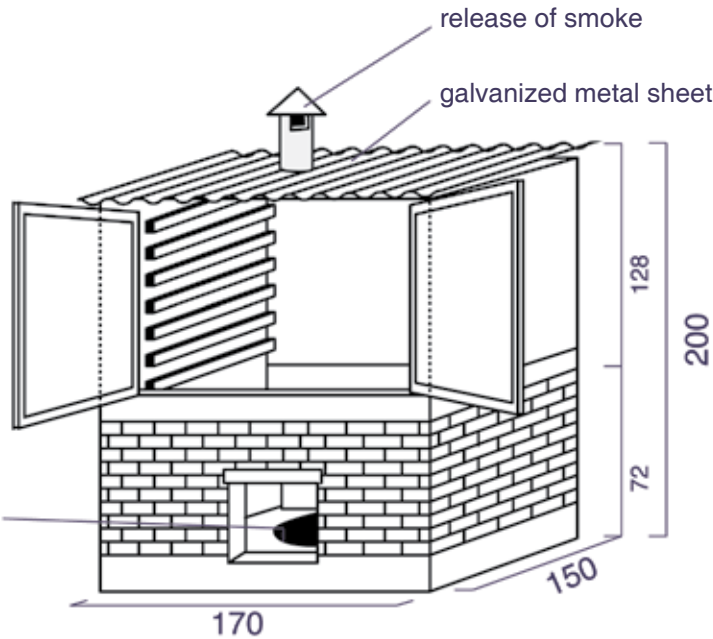
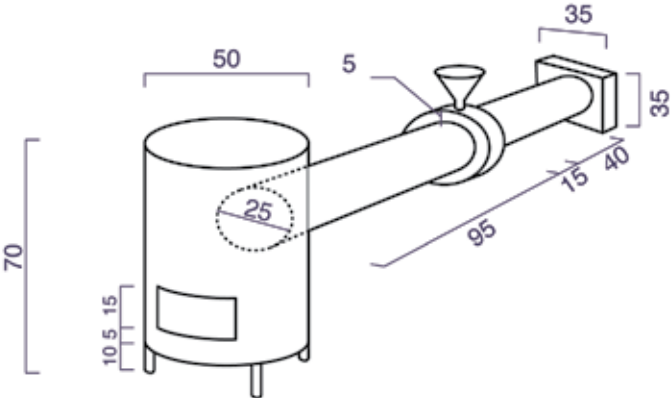
7.2 Chorkor FTT-Thiaroye kiln specifications



Sectional view



7.3 Altona FTT-Thiaroye kiln specifications



8. Bibliography

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Owing to its devices that are the ember furnace, the fat collection tray, the indirect smoke generator system and the hot air distributor, the FAO-Thiaroye processing technique (FTT-Thiaroye), focus of this methodological guide, strengthens the functions of existing improved smoking techniques in small-scale fisheries.

Superior and consistent quality and safe products, with a good value for money, and meeting food safety requirements are achieved in (i) complying with technical and sanitary engineering of the facilities to harbor it, (ii) following the instructions provided herewith regarding the design, construction and use of the assembled equipment, (iii) and applying good hygienic and good manufacturing practices. Indeed, the FTT-Thiaroye has the particular merit of overcoming the challenge linked to the polycyclic aromatic hydrocarbons (PAHs) given its feature which mainstreams the relevant code of practice of the Codex Alimentarius (CAC/RCP 68-2009). It further curbs the fuel consumption while reducing the exposure of the fish processor to the smoke and heat.

After a general overview of the comparative advantages of the FTT-Thiaroye, detailed information are provided to any development practitioner or any interested person or entity on the different components/devices, the supply in fuel, how to use and operate the FTT-Thiaroye, and how to care and maintain it.

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