FOODLAND

Training course packages targeting food operators on the adoption and management of the technological innovations

FISH SMOKING, SALTING, FERMENTING

Training guide / materials on development of primary products from farmed fish

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1. FoodLAND technical innovation for local food supply chains: concepts and approaches

The FoodLAND project has the ambition to impact on a large number of supply chains and communities, hence the process of food operators' capacity development has to be tailored and as much participative as possible. Accordingly, one of the assumptions of FoodLAND is that sustainable and nutrition-responsive farming systems can be achieved basically by strengthening the capacity development, and specifically by **a)** empowering farmers and processors through the implementation of capacity building processes and concrete opportunities; **b)** creating or consolidating cooperation and shared knowledge to overcome the lack of coordination among food operators; **c)** addressing the inefficient use of resources; **d)** trying to address and build resiliency to the high vulnerability of food systems to climate change; **e)** enhancing the integration of supply chains by creating commercial and stakeholders' networks; **f)** improving the responsiveness of the production sector to the market demand.

To implement these elements of capacity development, FoodLAND proposed the adoption of specific innovations, among which the organizational ones, to create strong and responsive links between producers and encompassing all the intermediate actors along the food value chain, such as researchers, SMEs, NGOs, local and national authorities. In order to ease the creation of those links and guarantee the sustainability over time of the results, 14 Food Hubs will be created in 6 countries as part of the organizational innovations. Food Hubs are conceived as multi-actors centers of innovation where to develop or enhance the organizational and operational conditions enabling local food supply chains (D3.6).

Functional to the implementation of the Food Hubs and of the innovations, the training courses were designed – in form of capacity development activities – as a two-phase process. Firstly, a training session focused on general, preparatory

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topics was provided to farmers as described and reported in D3.5 (“Group Introductory Training”, GIT). According to the project GA, GIT broad set of goals were: to enhance the knowledge of consumers’ nutritional needs and market opportunities, and to boost the notions about climate change, sustainability, resilience, and food culture. Secondly, a specific training session were organized to provide food operators with practical information on the adoption and management of the innovations tested at lab / small scale level and to contribute to validating them at appropriate scale.

However, as the whole approach has been designed by FoodLAND to ensure the inclusion of the local actors from the first moment, both the training sessions were set up accordingly. Indeed, yet in the inception phase of the project, an assessment on participatory methods has been run and Participatory Learning and Action (PLA) approach has been eventually assessed as the best one to ensure the inclusion of multiple perspectives. The main purpose of PLA is to support people within communities to analyze their own situation, rather than have it analyzed by outsiders, and to ensure that any learning is then translated into action (Gosling and Edwards 2003). In addition, a gender-sensitive approach has been applied to the trainings that have been designed considering gender roles and power relations; they have provided equal opportunities to participate in the process by caring to times, venues and use of local languages.

The GITs have been conceived as the first step towards the innovation validation and aim at involving the producers, yet from the inception phase. They are just the first step in a sequence of 6, summed up in **Table 1**. After the GITs, where farmers and processors meet and share their vision and goals for the Food Hubs and exchange information about specific topics, the Food Hubs were created and the innovation tested (first in pre-test, then in pilot phase). The constant iteration between researchers and local actors is a key feature of the project: specifically, the practical trainings focused the single innovations (step 5) are aimed at validating the innovations at adequate scale and planned to trigger feedback loops of control and improvement involving developers and adopters.

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Table 1. Activities with farmers and food processors (SMEs) and participatory approach

Step	1	2	3	4	5	6
Task	**T3.3**	**T3.3**	**T3.4**	**T4.1¸T4.5**	**T5.1¸T5.5**	**T5.1¸T5.5**
Activity	Group introductory training	Food Hubs creation	Innovation undertaking	Innovation tests	Individual and group practical training	Innovation pilot and validation

2. FoodLAND practical training: aims and scope

According to the project bottom-up and participatory approaches, following the courses on introductory topics GIT organized in the early project phase (T3.3), and as component creating / strengthening the Food Hubs as local innovation centres, FoodLAND has organized a second set of training activities with food operators based on active learning methods and gender equality principle (Task 5.1-5.9). In this regard, specific mechanisms (being aware of the gender roles and power relations; providing equal opportunities to participate in the process by putting attention to the times, venues, use of local languages, etc.) will be lifted to ensure women's participation. These training packages are aimed at providing the local farmers and food processors with operational instructions on the adoption and management of the validated innovations.

This second set of training activities has been organised – triggering PLA approach – as individual and group practical (demonstration/capacity building) activities to be conducted in parallel to the implementation of the technological research (where relevant) and of the innovation pilots and validation. These technology-centred trainings aim at strengthening the participants' understanding of novel production and post-harvest techniques, innovative tools and systems (e.g., climate smart/precision agriculture, hydroponics, and integrated aquaculture), new technologies for primary and secondary processing, and supply chain management. Thus they aim at fostering knowledge and operational

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capacity to deploy, manage, and maintain the validated technological innovations – documented by the released guidelines D4.1 ÷ D4.11 (e.g., training pamphlets, user manuals, flow diagrams, and operational recommendations) and practice abstracts D6.5 – validated jointly at appropriate scale.

3. Second training packages on the adoption and management of the tested innovations: an overview

The second training course aimed at consolidating the food operators' knowledge and practical skills to adopt, manage and validate the project innovations and complement the related guidelines. Specifically, the realized training materials provide local farmers and food operators with a set of notions and concrete information on a series of innovative tools and systems as per the following **Table 2**. It is clear that both the contents and formats of the learning packages widely differ across technologies as well as Food Hubs (when the same type of innovation must be validated in different contexts). The diversity that emerges from the proposed solutions reflects the different needs highlighted by farmers and stakeholders as well as the conditions and opportunities characterizing the local communities. Nevertheless, in order to take into due account the existing heterogeneity inside the local communities, the developed learning materials have been let available on the project intranet so as to be used for further training initiatives across the network of Food Hubs.

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4. Second training packages on practical information on the adoption and management of the tested innovations

Fish smoking, salting, fermenting

Training guide / materials on development of primary products from farmed fish

Target group: Fish farmers, processors, extension workers and traders

Aim of Training: To impart knowledge on low cost artisanal processes for preservation of farmed fish

Learning Outcomes:
By the end of the training, the participants should be able to:

identify and implement the value of maintaining the quality and safety of fish raw materials and finished products
create a demand for increased production that will lead to increased market niches for increased incomes

Topics for training

Introduction and overview to value addition
Sanitation and hygiene
Fish spoilage
Fresh fish handling
Quality and safety
Fish processing/preservation methods
Product diversity (primary products)
By-products processing

Teaching & Learning Methods:

Practical (hands on), power point presentations, excursion, discussions/brainstorming

Training materials Description
This material/module emphasises good hygienic and sanitary practices in handling and processing of farmed fish. It also provides information on mechanisms and drivers of fish spoilage. The standard operating procedures for handling and processing of fresh farmed fish. The core content of this manual are the protocols for primary fish processing namely; drying, salting, PAH-Safe smoking, milling and fermenting.

Assessment Methods and Duration
Learners demonstrating what they have learned
6hrs; 2 hrs of class; 4 hrs of practical

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Overview/Introduction

Fish and fishery products represent valuable sources of nutrients and contribute to diversified and healthy diets (FAO, 2013). Fish meat is a source of high biological value proteins, polyunsaturated fatty acids, vitamins and minerals, with the minerals mainly concentrated in the bones (Kabahenda et al., 2011). Fish is highly perishable due to high levels of moisture, less connective tissues, low levels of non-protein compounds among others. As such, at artisanal level, lack of ice and freezing facilities compel fish farmers to dehydrate the harvested fish using low cost preservation methods namely; smoking, drying, salting or a combination of the three. These primary processing methods are intended to extend marketing time for processed products from one day to several weeks. In addition, fermentation may also be applied to fish for the export market to regions who appreciate fermented product. However, under this project where zero waste is being promoted, the fish offals were fermented into silage as a base for livestock feed. Smoking entails dehydration, imparts antioxidant and antibacterial properties from the phenolic compounds. Technically at artisanal level, it is for impartation of smoky flavour. Traditionally, fish is smoked using local kilns, mud and wattle, altona kiln, mechanical, afos kiln and chokor kiln. However, the cited kilns expose fish to high levels of carcinogenic compounds (Polycyclic aromatic hydrocarbons, PAH) from the dispersed phase of smoke, for example benzoαpyrine. In 2019, the NARO team in NARL fabricated a PAH safe kiln to filter the carcinogenic compounds. Salting uses osmotic principle to dehydrate fish from 65-75% moisture to less than 20 %. Drying uses convection heat transfer in the open or in solar tents or mechanical drier.

Sanitation and hygiene

Sanitation **refers to** environmental and surrounding cleanliness

Hygiene **refers to** Personal/ self cleanliness.e.g communicable diseases, health aspects, sanitation,

Why should we keep the environment clean?

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Why should a person be clean?

Why should a fish processing plant and operatives/workers be clean?

Why Hygiene and sanitation

Ensure safety of fish and its products

Assure the market/consumers of standard operation practices in handling fish

Avoid contamination

Reduce infections and food poisoning

Ensure and maintain natural test of fish

Ensure quality and attach markets/ consumers ultimately high priced fish products

Increase shelf life of fish and its products

Hygiene and sanitation practices

At farm level

Maintain proper disposal of solid waste

Use clean toilets/latrines for disposal of excreta

Use proper wastewater drainage systems

Control animal movement at the fish processing site

At personal level

Always wash hands

You must not work when suffering from contagious infections to avoid transmission and contaminating the fish.

Wear clean protective clothing e.g. aprons, overcoats, headgears

Keep spare clothes and other personal items away from fish.

Ensure proper body hygiene e.g. bathing, trimming hair, nails

Avoid wearing jewelry on your hands when handling fish

Cover cuts or wounds with wound strip or a bandage

Wear disposable coloured gloves over the top of the wound strip if you have wounds on your hands.

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Fish spoilage

What is fish spoilage?

Deterioration that renders fish unsuitable for consumption

Why does fish spoil?

- High moisture content (65 – 80%)
- Very soft muscles

Highly susceptible to microbial spoilage

Rigor mortis phenomenon as a precursor for spoilage:

Pre-rigor and post-rigor

Mechanisms of spoilage:

Autolytic/self digestion (enzymic)

Microbial e.g. spoilers

Chemical (oxidative rancidity)

Main drivers of spoilage:

Time after death/ post-mortem

Temperature

Initial microbial load

Chemical composition

Handling practices

Other factors that drive spoilage

Fish condition (spawning, wellness, stress)

Sex

Type of species

Handling of farmed fresh fish

Because fish is perishable, it should be handled with care – No bruises.

Ensure humane killing of fish e.g. use of ice, CO_2, or electricity.

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Dip fish in a settlement water tank to remove muddy flavors before humane killing.

Do not degut or descale fish in absence of clean water and flake ice.

Fish processing/preservation methods

Because fish has limited shelf life in fresh form, preserved by - High or low temperature.

Industries use low temps to preserve e.g freezing and chilling.

All artisanal preservation methods e.g dip frying, smoking, open sun-drying use dehydration (High temps) to preserve. Salting uses osmotic pressure while Fermentation uses useful bacteria to preserve fish

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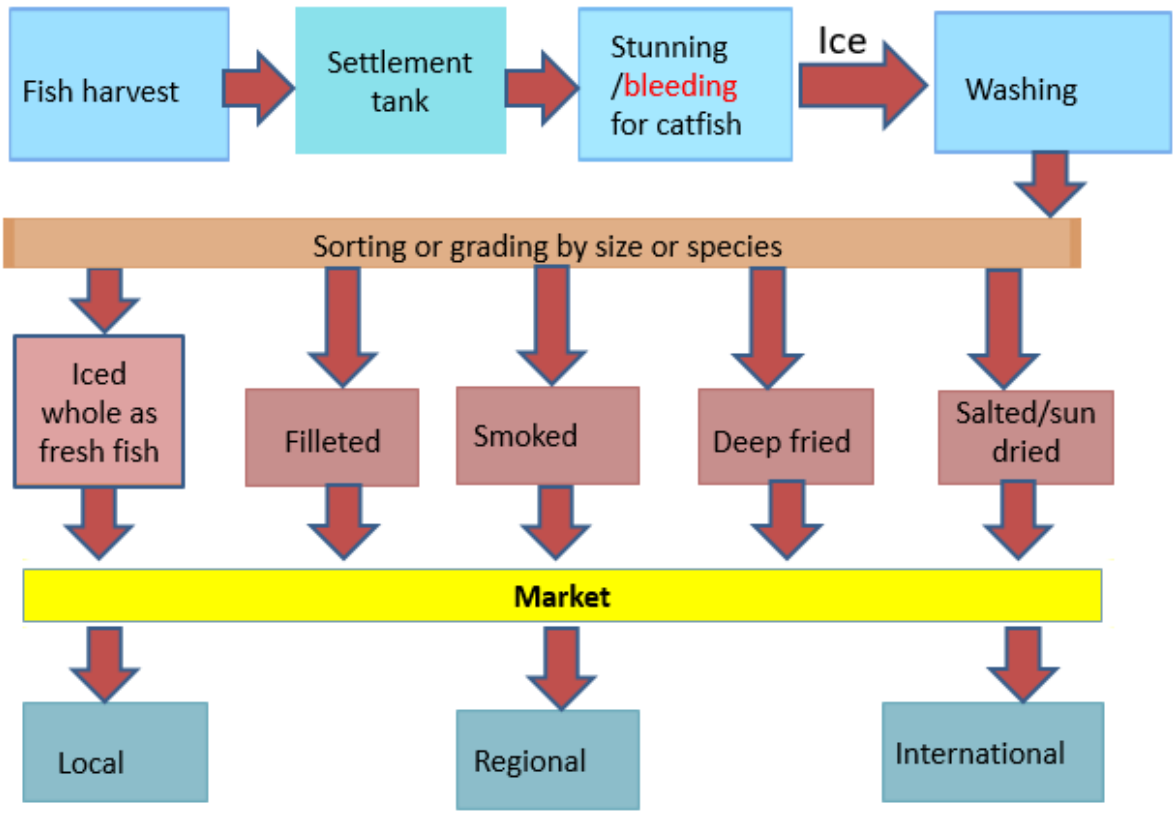

Primary processing

PAH-Safe Smoking

Smoking imparts smoky flavour, antioxidant and antibacterial properties from the phenolic compounds

Protocol

The processing steps are as follows;

All the fish were drip dried for 1 hour in the sun and then placed on trays inside the smoking kiln.

Different types of fish were placed into different chambers of the smoking kiln without cross contamination

Smoke was induced from matooke peelings and guava tree wood for a period of 3-4 hour at 40 °C (depending on the fat content of the fish species).

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This was gradually increased to 50 and 70 °C over a period of 4 hours.

The kiln temperature was gradually increased to 100 °C for a period of 3 hours

This was maintained for a further 2 hours after the fish had been turned over so that the side that was up is directly facing the oven bottom

Then remove the heat source and allow the fish to cool to room temperature before packaging

The smoked products were put on stainless steel trays for inspection

Package in well ventilated waxed boxes and store at ambient temperature ready for market

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Salting

Salting uses osmotic principle to dehydrate fish from 75% moisture to less than 65 %.

Protocol

The split and washed fish were sliced into thinner portions (10mm thick).

The portions were salted in 1:20 ratio (that is 0.25kg salt for 5kg fresh fish) then put on stainless trays overnight slanted at 20 °C.

The fish portions were then spread on a raised rack mesh surface at ambient temperatures (26 - 30°C).

The racks are slanted at a 20 °C angle to aid drainage of excess water

The raised surface was elevated at 1M above the ground.

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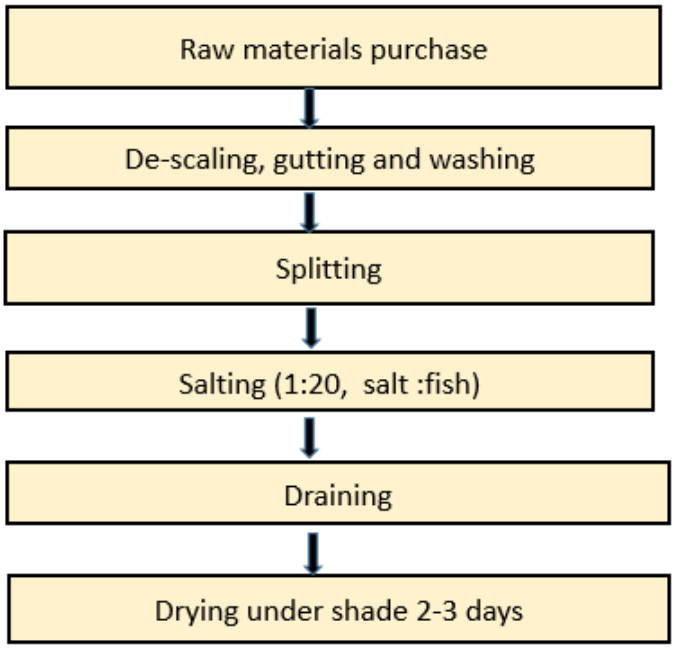
Portions of large fish were also turned regularly (every 1 hour) and dried for 2 - 3 days. (duration depends on the thickness and fat content of the fish as well as ambient temperature and humidity)

The resultant salted and dried products were packaged in the ventilated waxed boxes and stored at room temperature ready for market



Drying

Drying uses convection heat transfer in the open or in solar tents or mechanical drier.

Solar drier contains a black body which absorbs heat during day and continues drying in the night.

Protocol

The split and thoroughly washed fish (as in the previous sub-section) fish was sliced into thinner portions (10mm thickness) to facilitate the drying process.

Drip dry in the shade for 2-3 hours to avoid case hardening

These portions were spreading on a drying rack at ambient temperatures (26 - 30°C).

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The drying rack was elevated at 1M above the ground.

These were turned at regular intervals (1 hour) and dried for approximately 2 - 4 days. (duration depends on the thickness and fat content of the fish as well as ambient temperature and humidity).

Dried products were packaged in the ventilated waxed boxes and stored at room temperature ready for market.

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Milling/Fish Powder

Preparation of fish powder from bones by milling is shown in **Fig. 4**. The process is as follows;

Fish carcasses were used as base material

Separate by-products into respective components (parts). The belly-flaps and all fatty material should be removed from carcasses.

Wash with potable water at room temperature

Heat at 80 °C for 15 minutes to inactivate enzymes and spoilage organisms.

Drain excess fluid.

Oven dry at 60°C until brittle (≤ 10% moisture content)

Milling using a hammer mill made from food grade materials with a sieve mesh size of 0.5mm.

Quality control – check to sort out coarse material

Vacuum pack into consumer packs (10g, 50g, 100g, 500g, 1000g)

Store in a cool, dark and dry place

Fermentation

Fish offals were fermented using Lactic Acid Bacteria t produce a hydrolysate which was then reconstituted with cassava flour/maize bran to enhance it's solids content and shelf stability. The process is described as follows;

Wash the fish waste and containers to be used under running water

Weigh/determine the volume of the fish waste

Comminute and blend the fish waste using a knife and blender/food processor respectively

Add clean/potable water (ordinary boiled water) to the homogenate in a ratio of 1:1 i.e. 1 part water to 1 part fish waste. If using chlorinated water, leave

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the water to sit overnight to allow the chlorine to dissipate. Chlorine is an antimicrobial agent.

Homogenize the mixture by agitation/stirring

Add lyophilized LAB at an inoculation rate of 0.02%.

Add sugar at a rate of 8.5% of the total volume of mixture

Stir the mixture to homogeneity

Transfer the mixture to the fermentation vessel (jerry can, vat, demijohn etc.) (20L Jerry can)

The vessel may be loosely capped however, an airlock should be used to cap the vessel and allow for anaerobic fermentation while containing the unpleasant odour from gases produced especially carbondioxide (airlock was used)

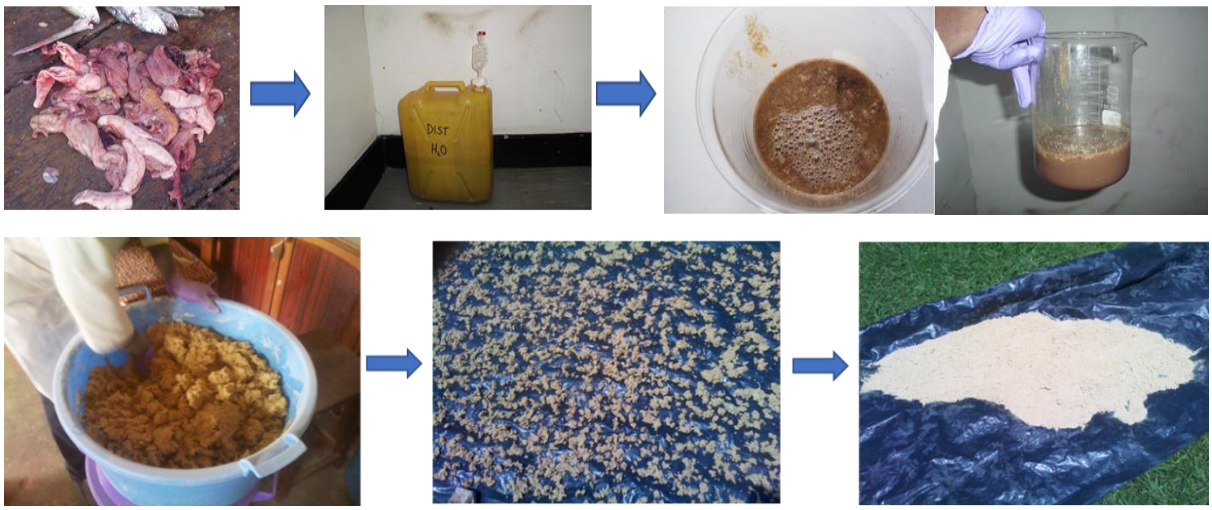
Fermentation proceeds at ambient temperature (25 - 30 °C) for 3-4 week.

The fermentation is complete when a faint vinegar odor replaces the previous putrid odor

Enhance the carbohydrate/solids content of the fish hydrolysate by adding cassava flour/maize bran in a ratio of 1:1

Mix to homogeneity

Sun-dry the mixture on tarpaulin/black polythene sheet for approximately 48 hrs.



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