# SMALL FISH AND FOOD SECURITY: TOWARDS INNOVATIVE INTEGRATION OF FISH IN AFRICAN FOOD SYSTEMS TO IMPROVE NUTRITION

# TECHNOLOGY TRANSFER REPORT ON THE SMALLFISHFOOD PROJECT


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# 1.0 Introduction

The most common fish species landed in Ghana are the small pelagics, such as mackerel, horse mackerel, chub mackerel, sardines, and anchovies. These small pelagic species account for about 70 percent of the total marine fish capture in Ghana (FAO, 2020). Traditionally pelagics are used in the preparation of sauces, soups and can also be used as an alternative source of protein in toddlers in the form of fish power products. While it is estimated that the small pelagic fish industry contributes to the livelihoods of almost a tenth of Ghana's population, its importance and uses in the diets of average Ghanaians is less clearly understood beyond a recognition that it forms a significant component of the diets of Ghanaians, given that some traditional meals require the use of specific types of small pelagic fish. In spite of its significance to the diets of Ghanaians, the quality of this fish cannot always be guaranteed. In addition, the availability of this fish at affordable prices is location-specific with coastal communities having much easier access to fresh, higher quality fish than inland communities. Given these conditions, this project seeks to explore the overall role of small pelagic fish in the diets of low income households. The LEAP-agri "SmallFishFood" project offers innovative thinking focusing on how utilization of small fish (often labelled as trashfish) can be transformed in a direction where fisheries governance, marketing mechanisms and health policies ensure that the value of these fish are recognized and utilized sustainably for human consumption and good health.

## 1.1 Importance of Fish Drying

The post-harvest drying of agricultural and fisheries products is of great economic and industrial importance to stakeholders and players in the food sector. Drying reduces moisture levels in agricultural produce to appreciable levels in order to reduce the activities of microbes and food deteriorating organisms. Consumption of fish has also been on the ascendency in recent times due to the associated health benefits.

Edible fishes are preserved through removal of moisture. The basic principle of fish drying is that the activity of the muscle enzyme and microorganism is reduced to a minimum through the revocation of the water content of the fish by sun drying in a traditional way (Das and Hossain, 2015).

Although pelagics are a rich source of micronutrients such as Vitamin A, Calcium, Iron, Zinc and polyunsaturated fatty acid (Eicosapentaenoic acid and Docosahexanaenoic acid) (Belton & Thilsted, 2014), its perishable nature and seasonality limits the scope of utilization. Drying serves as a means of reducing perishability and extending the shelf life. Drying is necessary to reduce their water activity, prevent microbial spoilage, reduce weight, decrease packaging, handling as well as transportation costs.

The knowledge on the various aspects of post-harvest handling, processing, distribution and socio-economic condition of dried fish are significant in the implementation and development of linkage for value addition and quality control with consequent economic and employment benefits (Marine et al., 2015).

## 1.2 Advantages of Fish Drying

- Dried fish is highly concentrated fish compared to other preserved form of fish.
- As water content become reduced so microbial activity cannot run at normal rate thus reduce the rate of spoilage and increase shelf life
- Less expensive method and comparatively simple procedure.
- Reduced water content, enzymatic and many chemical processes which are responsible for fish spoilage retarded.
- In this method, complicated machinery and equipment are not required.
- Dried fish remain stable at most ambient temperature.

## 1.3 Existing Approach

In the Greater Accra Region, majority of fish processors engaged in fish drying do so by spreading on the bare floor along the beaches, in open spaces and along sections of roads. This approach exposes the fish to high levels of contamination from dust in the environment, bird droppings, exhaust smoke and contact from rodents. There is also the possibility of losses through pest activities

Figure 1 Drying of fish on bare ground

Another method identified in the course of research work involves the spreading of fish on stones along the beach to facilitate drying through direct solar radiation.

Figure 2 Drying of fish on stones

# 2.0 Research Perspective and Design Considerations

## 2.1 Introduction to Research Perspective

The foremost consideration when selecting a dryer is its operability. Most importantly, a dryer must produce the desired product in the desired form at the desired rate. The finished product quality required its necessary physical and chemical characteristics, usually influence the quality and properties of the food product to be developed from the dried product. A wrong dryer for a given application is still a poor dryer, regardless of how well it is designed.

Above all, a dryer must operate reliably, safely and economically. Operational and maintenance costs should not be excessive; environmentally polluting emissions must be controlled; energy consumption must be minimized so as to gain the highest efficiency. As with other equipment the afore mentioned requirements may sometimes conflict one another and a middle ground needs to be reached in finding the optimum dryer for a given service.

## 2.2 Design Considerations

After a careful study of the existing designs and structures taking into consideration advantages and disadvantages regarding shelf life and safety of fish, three modified fish drying platforms were designed.

The design considerations that came into play included the following;

Ergonomic consideration: It has been known for years that most fish processors are women. These women tend to do a lot of bending in order to spread the fish on the bare floor or on flat stones. This modified drying platform had an increased above-ground height of 3ft (figure 3) to reduce drudgery (brings height to waist level) associated with frequent bending which may be linked to future health problems

Figure 3 Three feet floor height highlighting ergonomic design considerations

Fatigue Consideration: Usually women processors go back into the midday sunlight to turn over the fish unto its other side to ensure that drying occurs on both sides. This has been catered for through the introduction of modified drying racks that enable 2 women to stand opposite each other, hold the extended handles of the rack and flip the entire rack $180^0$ unto its back side. This increases turnaround time for the dried fish and also reduces the time spent in the harsh sunlight working on the fish.

Safety Consideration: Another pressing issue that has been tackled in the new rack design is the introduction of sieving material in the rack construction. This serves as a barrier for flies and other insects that have the potential to introduce disease-causing organisms as well as cause illness in humans. The sieves inhibit direct contact by houseflies which have the potential to introduce foodborne pathogens including Salmonella, Shigella and Enteropathogenic *E.coli* (Olsen, 1998).

Figure 4a Spreading fish in improved drying rack

Figure 4b Improved drying rack placed under the sun

Safety Consideration: The introduction of a $9^0$ angle of slope in the drying platform construction ensures that oils and other fluids from fish being dried does not accumulate on the platform to serve as a hotspot for bacteria growth. The slope ensures that these fluids are drained off the fish and also makes it easier to clean the platform after drying.

Figure 5 Drying platform depicting gentle angle of slope

Mechanical Strength Consideration: The concrete construction with iron rod reinforcements and 3inch thick plastering is expected to last for years without failure. Heat vents have also been constructed on all the four sides of the platform to ensure that temperature build-up within the concrete can be released without causing cracks on the surface of the platform. It will also be able to stand the weight of fish and racks

Energy Consideration: Due to the siting of the dryer along the beach and in fishing communities which have little or no access to electricity, the drying platform does not utilize electricity in any of its operations as it relies entirely on sun energy. Hence there will be no electricity charges associated with its use. To improve the rate of drying, the sides of platform was painted black. This serves to increase the rate of solar energy absorption and hence increases the rate of evaporation of fluids from fish. The recommended drying temperature for fruits and vegetables as researched by Arinze et al (1990) to reduce their moisture content

to 7-15% is between 35 and 63$^{O}$C. Data collected from the drying platform in the months of October and November 2019 gave an average temperature of 55 to 65.

Loading capacity: Approximately 2.5kg of pelegics are spread on each improved rack. The ability of the platform to hold 10 racks provides a round figure of 25kg for the fish processors

Air Gap: It is recommended for passive solar dryers to maintain a 10cm air gap (Gupta et al., 2017). The improved racks have an air gap of 10cm to allow the free flow of air under and around the fish product being dried.

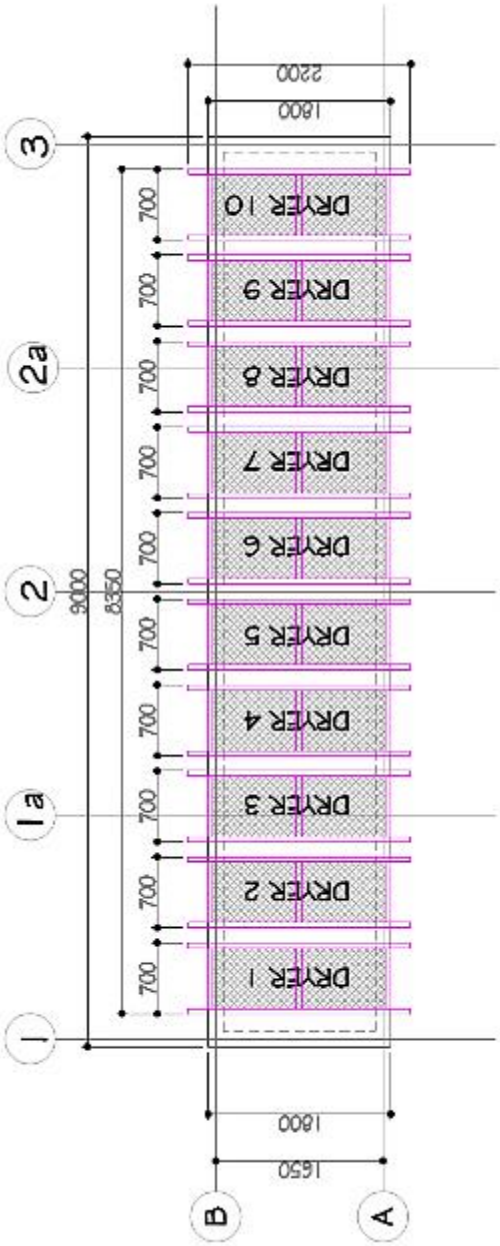


Figure 6. Panel Layout Plan

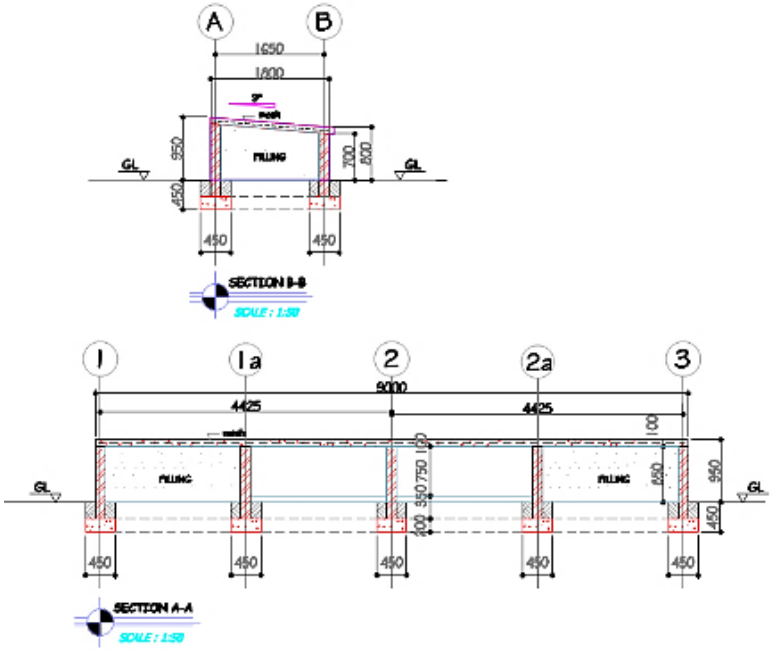


Figure 7. Sectional Elevations

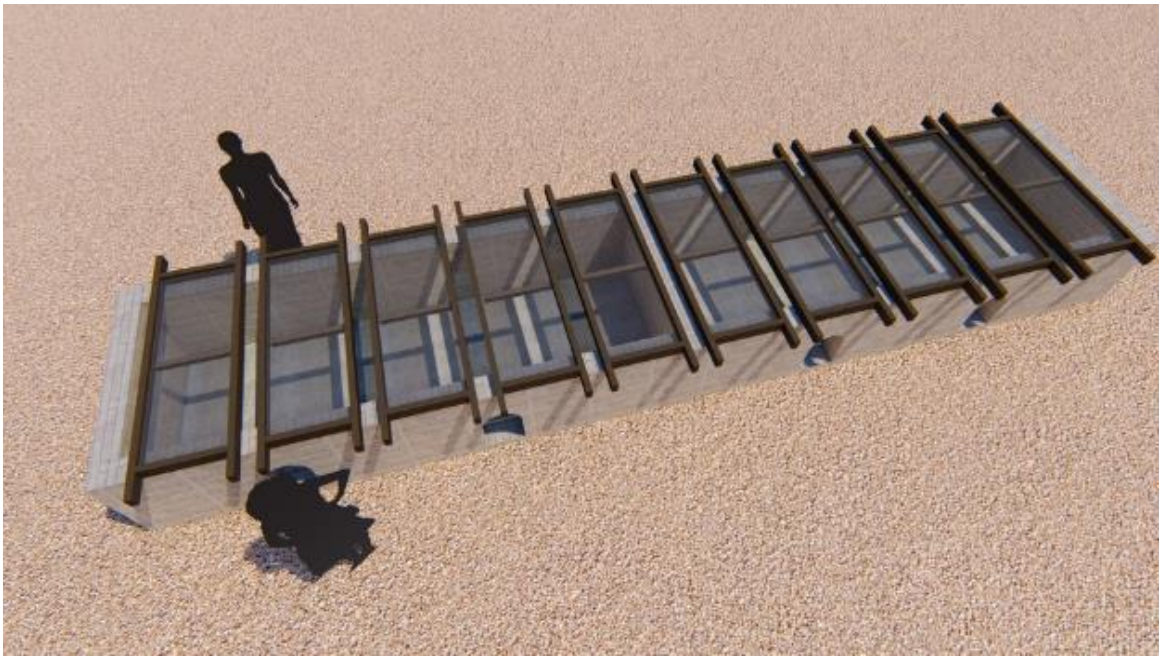

Figure 8. 3D Impression of Solar Drying Platform

In the course of design and construction of the solar platform dryer, other design variants came up which include these three;

a) The first is made from cement blocks and concrete mixture and forms a rectangular prism block. The four sides (excluding the very top and bottom) are painted black to retain heat for prolonged drying (figure 9)
b) The second is also made from cement blocks and concrete mixture. The major difference being that an extra space is provided in the mid-section of the platform for storage of racks and other containers (figure 10).

Figure 9 Solid concrete platform

Figure 10 Concrete platform with storage space for racks

c) The third type is made purely from dahoma timber (figure 11a & 11b). The wood is treated to prevent infestation by pests and insects and the foundation is well grounded by placing the footings 3 feet deep into the ground and concealing it in concrete. This type can accommodate 20 racks.

Figure 11a Side view of Timber platform dryer

Figure 11b End view of Timber platform dryer

## 3.0 Adoption Challenges

Every culture has a bit of uneasiness when new technology is introduced that has the possibility of influencing the lifestyle of its people. Hence there are bound to be adoption challenges with respect to the solar drying platform. Some of the foreseen challenges have been documented and reported as follows;

Generally, fish processors along the coast are used to spreading fish on the bare ground along the beached to dry. A major adoption challenge envisaged would be attitudinal or behavioral change towards the new safer method of drying.

Also, construction of these platforms requires the purchase of certain items. The cost involved may be a deterrent to fish processors when adopting the new technology.

Lack of access to land for the construction of platform may also pose a challenge

Remote location of processing site from the beach

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