Ensuring Food Security by Reduction of Post-Harvest Fish Losses in Small-Scale Fisheries, Nigeria

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***Abstract*—** *This paper focus on types, causes and how post-harvest fish losses can be reduced in the artisanal fisheries sector to ensure food security and provision of adequate protein for the increasing population. Post-harvest fish loss is a serious threat to the artisanal fisheries sector which occurs from the capture to the final stage of marketing the product to the consumers. When fish undergoes microbiological decay, it leads to quality loss which results to depreciation in the market value. Consumption of such fish has adverse effect on human health; as a result of these, method of assessing post-harvest fish loss and ways of reducing it should be discovered in order to have good quality fish in abundance for the ever growing population and also improved livelihood of fisher folks.*

Keywords*— *Food security, Post-harvest fish losses, Artisanal fisheries sector, Livelihood.

I. INTRODUCTION

Major challenges faced globally are on how to improve food security to meet up with the world rising population and ensure sustainability. Over the years, studies have shown that food security can be improved if fish produced are properly used and this can be done through reduction of post-harvest losses in different distribution stages involved (FAO, 2010, Kumolou-Johnson & Ndimele, 2011).

Food security takes into consideration availability, accessibility, sustainability and utilization of food to ensure people have access to the basic food required (Kumolu-Johnson & Ndimele, 2011). The role of fisheries towards supply of animal protein in many industrialised and developing countries cannot be under estimated (Adewolu & Adeoti, 2010). Some communities in Low-Income Food-Deficit Countries (LIFDCs) rely on fish not just for protein source but likewise as micronutrients source which include essential fatty acids and minerals. Other alternatives for these sources are expensive and fish was considered as a better option (FAO, 2010; Getu *et. al.*, 2015). This was in agreement with Domingo *et. al.* (2007) stating that fish has high-quality of protein and provides 17% of total animal protein, 6% protein of human consumption, vitamins and other vital nutrients.

II. ARTISANAL FISHERIES SECTOR IN NIGERIA

In Nigeria, fisheries sector is sub-divided into artisanal, commercial and aquaculture fisheries (Oladimeji *et. al.*, 2013; Okeowo *et. al.*, 2015). Another name for artisanal fisheries is called small-scale fisheries due to the use of out-dated traditional fishing equipment such as small boat, low cost of operation, low capital expenses and low innovation (Adedokun *et. al.*, 2006; Oladimeji *et. al.*, 2013). Fish generate income which serves as source of livelihood for millions of people (Nowsad, 2010). Population of Nigeria which is over 180 million currently has been estimated by United Nations that there is a tendency for increase in demand of fish protein by additional 700,000 metric tonnes by 2020 due to increase in population which is likely to surpass 210 million by then.

According to Food and Agricultural Organization (FAO), fish consumption per person in Nigeria at the moment is 7.5 kilos which is opposing to 18.7 kilos global fish consumption per person. This shows a large deficit of 11.2 kilos of fish consumption per person in the country. Gbolagunte *et. al.* (2012) stated that in adult, total protein intake is over 60% which fish serves as the main factor supplying balanced vitamins, minerals and protein mostly in the rural areas. Fish is a highly perishable food which needs to be suitably handled, processed and marketed to reduce post-harvest losses (Nowsad, 2010). In fisheries sector, quantity and quality losses are very high which leads to nutritional loss of fish. Review of case studies of post-harvest losses in several countries in Africa shows high level of losses both quality and quantity (physical losses) of fishery products Reduction of post-harvest losses started after the mid-1970s food crisis and ever since then the problem still persists. This issue led the United Nations in 1975 to notify the attention of worldwide towards post-harvest losses reduction in developing countries that needs immediate intervention. Studies have shown in underdeveloped and developed countries that losses both quantity and quality takes place at all phases along the production chain, from harvesting, processing, storage, transportation, marketing till it gets to the final consumers (Kabahenda *et. al.*, 2009; Olusegun & Matthew, 2016).

Post-harvest losses reduction has commenced since the food crisis issue in mid-1970s and subsequently the problem continues. As a result of this, United Nations in 1975 seek immediate intervention globally towards reduction of post-harvest losses in developing countries (FAO, 1992; Patience & Campus, 2014). In 1992, meeting was held by Strategy for International Fisheries Research (SIFR) which concluded that developing a systematic approach for fish loss assessment should be the major concern of researchers (Ward, 1996, Mungai, 2014). Figure. 1 shows the three fisheries sub-sector where artisanal fisheries sub-sector account for over 80% of total fish production in Nigeria. But despite this, it is challenged with 30 – 50% post-harvest fish losses of landed weight (Adesehinwa *et. al.*, 2005; Emere & Dibal, 2013; Olusegun & Matthew, 2016). These losses as caused a serious threat to the artisanal fisheries sector in Nigeria. It occurs along the fish distribution chain from capture to marketing stage (Diei-Ouadi &Mgawe, 2011; Olusegun & Matthew, 2016). This issue has been a great concern especially to development practitioners whose main focus is to improve fisher's livelihood, processors, and marketers and ensure food security. FAO code of Conduct for Responsible Fisheries (CCRF) under Article 11.1 recognises the problem which fish loss poses and importance on loss reduction. In other to ensure that the supply shortage of 2.04 million metric tonnes which is as a result of wide gap between demand and supply is met, post-harvest fish losses needs to be reduced (Ward, 1998; Ibengwe & Kristofersson, 2012; CBN, 2014)

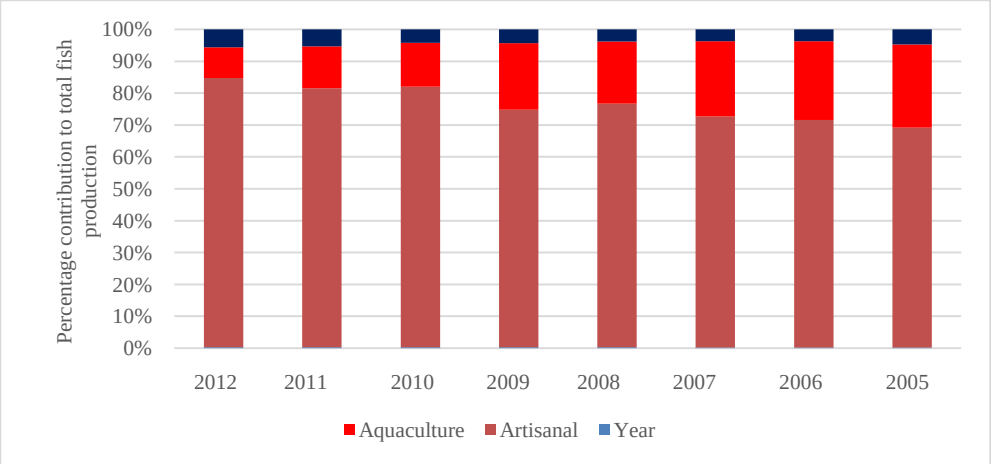

FIGURE 1: CHART SHOWING PERCENTAGE CONTRIBUTION OF EACH SECTOR TO FISH SUPPLY IN NIGERIA FROM 2005 – 2012
SOURCE: UNPUBLISHED FDF, AKINTOLA AND FAKOYA (2017)

III. POST-HARVEST FISH LOSSES

This refers to discarding of fish or selling of fish at relatively low price due to quality deterioration. This leads to potential loss of income for the fishers, processors and marketers. This also makes availability of fish to be reduced to consumers or fish with low quality value is supplied to them (Diei-Ouadi & Mgawe, 2011). It has been discovered that high level of post-harvest losses occurs during handling, processing, storage, transportation and marketing of fish (Singh et. al., 2012; Rahman et. al., 2013). Losses are as a result of poor processing practices causing damage to the fish; insect infestation; inadequate packaging; lack of storage facilities; lack of good roads leading to damage of fish products (Diei-Ouadi & Mgawe, 2011; Mungai, 2014). Post-harvest fish loss has been seen as a constraint to planning at the state and country level due to lack of qualitative and quantitative data.

3.1 Types of post-harvest fish losses

There are three types of post-harvest fish losses physical losses, nutritional losses and economic losses (Ames, 1990; Eyo, 2001).

Physical losses of fish are majorly as a result of poor handling and discard of by catch at sea due to being small or will not attract good value (Olusegun & Matthew, 2016; Diei-Ouadi & Mgawe, 2011). It can be defined as fish loss either entirely or losses which involve certain parts of the fish through insects' infestation, theft of by animal predation (Eyo, 1997). Dried fish which have been infested by beetles or maggots or fish that fall into fire during smoking are all classified under physical loss (Eyo, 1997; Kumolu-Johnson & Ndimele, 2011).

Nutritional losses is defined as nutritional value loss of fish due to spoilage or exposure to high temperature during smoking causing deterioration of fish to the extent that it is not fit for human consumption. Nutritional values decreases in fish as its

spoils because degradation of protein occurs due to bacteria causing spoilage (Eyo, 1997; Kabahenda et. al., 20009; Getu et. al., 2015). Actions of bacteria on the fish produces harmful odours and becomes unattractive for consumption (Kumolu-Johnson & Ndimele, 2011).

Economic losses occur when fish which is meant for human consumption is downgraded due to spoilage which leads to decrease in value. This loss leads to physical and financial losses of product as a result of quality fish deterioration. This fish will be sold out at a lower price against the amount it ought to be sold. This is as a result of lack of appropriate preservation through use of ice for fresh fish, poor transportation and inadequate market information, processed fish are stored for a longer period of time which encourages spoilage to set in and fish degradation occur resulting to selling in low prices (Eyo, 1997; Diei-Ouadi & Mgawe, 2011; Hassan, Rahman, Hossain, Nowsad, & Hossain, 2013).

Market losses are caused due to shortage existing between demand and supply which leads to fish price changes. If there is a fall in fish price due to oversupply, marketers experience market loss (Mungai, 2014; Olusegun & Matthew, 2016).

3.2 Causes of post-harvest fish losses

3.2.1 Fish spoilage

Fish is highly perishable and spoils immediately after death as soon as rigor mortis sets in (Getu et. al., 2015; Mohammed, 2015; Adeyeye, 2016). Rigor mortis is the stiffening of fish muscle tissue which starts between 1 – 7 hours after death. The sum of duration is calculated to be between 30 – 120 hours while fish that are suffocated and not preserved with ice indicate shorter period of fish muscle toughening between 32 – 93 hours. Studies have shown that rigor mortis stays for a longer period when fish has utilized less muscular movement prior to death and refrigerated immediately (Huss, 1995; Cook, 2008; Santoso & Yasin, 2010). Prior to and throughout the rigor mortis stage, fish should be handled properly during catching, removal from the net, throwing of fish should be done with little bruise on board and anaesthesia should be given to the fish (Shim & Cho, 2014). Reviewed literatures explains that immediately fish dies, device used for defence stops while enzymatic, oxidative and bacteriological spoilage set in to cause deterioration of fish quality (Diei-Ouadi & Mgawe, 2011). Assessment of post-harvest losses studies revealed that fish losses of about 10 to 12 million tonnes per year is caused by spoilage while estimate shows that 20 million tonnes of fish are discarded at sea yearly (FAO, 2010, Kumolu-Johnson & Ndimele, 2011).

Findings have revealed that high temperature leads to fish spoilage at different stages of fish production particularly in the tropical countries. Activities of micro-organisms, protein and fat oxidation in the fish body is increased (Ababouch, 2005; Mungai, 2014). Also, Diei-Ouadi and Mgawe (2011) support the findings stating that high temperature of about 20^0C create avenue for fish spoilage while low temperature of 5^0C slows down bacteria activity and spoilage rate. Signs of fish spoilage include slime formation, texture changes and discoloration with time and off-odours detection. Olusegun and Matthew (2016) revealed that high fish spoilage at the landing site was a s result of poor handling practices by the fishers. It was discovered that no washing, gutting and clean storage of fish was done on board or at the landing site.

3.2.2 Time

Studies by Bataringaya (2007) indicated that delay of fish arrival at the landing site in respect to time also cause fish rejection due to microbial growth. Rate of spoilage increase when landed fish are not iced immediately before selling to the middlemen. This is in agreement with Diei-Ouadi and Mgawe (2011) findings which stated that fresh fish spoilage rate is influenced by time and hours spent in the fishing nets. Also, Bolorunduro, Adesehinwa and. Ayanda, (2005) and Kumolu-Johnson and Ndimele, (2011) stated that time in between fish catch and preservation preparation also leads to fish losses. According to Abbas, Saleh, Mohamed & Lasekan,(2009) several biological and chemical changes occur in the dead fish immediately after capture which is likely to lead to rejection for consumption as a result of spoilage and being harmful to human health. Mungai (2014) suggested that fishermen should reduce the fishing cycle length in order to reduce post-harvest losses and also use ice on-board and adequate training should be provided on fish handling practices to reduce post-harvest losses.

3.2.3 Infrastructural facilities

According to Ghaly, Dave, Budge and Brooks (2010) over 30% of landed fish landed are lost due to bacterial activity as a result of lack of storage facilities and ice for preservation. This leads to softness of fish flesh or watery or tough and dry once bacterial spoilage set in. The fish becomes putrid and inedible for human consumption. Literatures (Kwangwa and Odongkara, 2005; Tesfay & Teferi, 2017) specified that lack of facilities, lack of awareness, poor transportation and

inaccessibility of ice are also part of what leads to fish losses. Table 1 shows the different stages and causes of post-harvest fish losses.

TABLE 1
STAGES AND CAUSES OF POST-HARVEST LOSSES IN FISH PRODUCTION

Stage	Causes	Loss type
Fishing	Fishing involving use of harmful methods such as poison, dynamite which result to harvesting of damaged fish	
	When fishing gear is set for a long period resulting to fish spoilage before gear is hauled.	Physical
	Fish discarded as bycatch or fall from the net	Physical
Fish on board	Exposure of fish to high ambient temperatures at sea during delay of landing of fish.	Physical, Nutritional
	Degut, wash and chill the fish on board is not done	Nutritional
	Mistakenly stepping on fish leads to physical damage	Physical, Nutritional
Unloading of fish	Lack of hygienic practices causing contamination	Nutritional
	Falling of fish from the basket on to the shore	Physical
	Fish exposed to high ambient temperature and kept on the ground for a long bargaining time	Nutritional
Fresh fish marketing	Lack of insulated container and inadequate application of ice	Physical, Nutritional
	During extra-large catches, inadequate preservation capacity e.g. processing equipment, ice	Physical, Nutritional
	Traders deliberately delayed purchasing of fish	Nutritional
During processing and packaging	Processing of spoilt or poor quality fish	Physical, Nutritional
	Infestation of blowfly through processing of fish under unhygienic conditions	Physical, Nutritional
	Over smoking or burning of fish due to uncontrollable heat intensity during processing	Physical, Nutritional
	Unsupervised drying of fish on ground, rocks or herbs	Physical, Nutritional
	Inadequate packaging method leading to fish breakage	Physical, Nutritional
Storage	Spoilage caused by growth of mould making fish damp	Nutritional
	Insect infestation on fish during storage	Physical, Nutritional
	Fish discoloration due to chemical changes	Nutritional
	Inadequate storage facilities	Physical, Nutritional
Distribution	Fish breakage during transportation	Physical
I.	Breakdown of transport vehicles resulting to delays and inaccessibility of production areas.	Physical, Nutritional
Marketing	Inadequate cold-storage facilities and lack of ice	Physical, Nutritional
	Selling of fish delay	Nutritional
	Fish supply to the market at the wrong time	Market
	Low purchasing power of consumers	Market

Adopted from Diei-Ouadi and Mgawe (2011)

3.3 Ways of reducing post-harvest fish losses

Reduction of post-harvest losses in fisheries sector becomes paramount after understanding the causes and stages at which it occurs in order to proffer solution. Handling practices is one of the major point of reducing fish post-harvest losses. According to Huss (1994) and Kyangwa and Odongkara (2005) the major practice for safeguarding fish quality and safety is through fish handling. This is in agreement with Das, Kumar, Debnath, Choudhury and Mugaonkar (2013) stating that fish quality depends on the handling method used during landing, processing, storage, packaging and transportation. Careful methods will retard spoilage, reduce losses and improve the quality of the marketed produce. Quality of fish and safety is the major concern of consumers which can be achieved through adequate hygienic practices among fishermen and fish processors (Balasubramaniam, Charles & Krishna, 2009; Singh et. al., 2012). Also, Olusegun and Matthew (2016) revealed that reduction of fishing time to minimum of 12 hours will help the fish caught to remain in good condition. In addition, good handling practices of fish on board by washing, gutting and storing in clean containers will help to reduce losses.

IV. CONCLUSION

Fishermen needs to be trained on proper fish handling and hygiene to ensure food safety production. Provision of infrastructural facilities such as cold storage equipment, processing facilities and good road network to maintain good quality of fish and ease transportation. Ice should be provided for fishermen during capture and landing in order to preserve the fresh fish for a longer period of time. Also access to loan/subsidies should be provided for fisher folks which will help to boost fish production level. Intervention regarding fisheries related policy on post-harvest loss should be set by the government to cover the future development of the fishery.

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