PROFITABILITY AND POST-HARVEST LOSS ASSESSMENT ALONG FISH VALUE CHAIN ASSOCIATED WITH BAROTSE FLOODPLAIN, ZAMBIA

CHIFUNIRO SOMANJE

MASTER OF SCIENCE

(RESEARCH METHODS)

JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY

2016

Profitability and Post-Harvest Loss Assessment along Fish Value Chain Associated with Barotse Floodplain, Zambia

Chifuniro Somanje

A research project submitted to the Department of Horticulture in the Faculty of Agriculture in partial fulfillment of the requirements for the award of a Master of Science Degree in Research Methods of Jomo Kenyatta University of Agriculture and Technology

2016

DECLARATION AND APPROVAL

This research project is my original work and has not been presented for a degree in any other University

………………….. **…………………**

Signature Date

Chifuniro Somanje

This research project has been submitted for examination with my approval as University Supervisor

……………… **……………….**

Signature Date

Prof Kavoi Mutuku Muendo

Department of Agriculture and Resource Economics

DEDICATION

This work is dedicated to my husband, Innocent Mankhwala for his patience, encouragement, love and support through the study and research period. Together we have painted a brighter future full of possibilities. I would never have achieved this goal without your unconditional support and valuable sacrifice.

ACKNOWLEDGEMENTS

This work would not have been possible without the assistance and support I received from many people. I am most grateful to my supervisor Prof Kavoi Muendo from Jomo Kenyatta University of Agriculture and Technology for his tireless support and guidance throughout the study and for the invaluable time he has invested in shaping the outcome of my work.

I am grateful for technical assistance and financial support I received from WorldFish and Department of Fisheries in Zambia under Cultivate Africa's future project during data collection and final research project development. Thanks also to the individuals who provided the information used in compiling this research project. Their cooperation made my study a success.

I also would like to thank RUFORUM for sponsoring my coursework and part of my research. Your sponsorship turned my dream into reality. Thanks also to all fellow graduate students (Research Methods of 2014) for their strong sense of friendship, cooperation during the study period. Thanks to my extended family for their affection, encouragement and perpetual prayers during my studies.

Above all, I thank God Almighty for His love and grace that has seen me through all times.

ABSTRACT

Fish is of great economic, social and nutritional importance to a large population of Africa. It contributes to food security, income, poverty reduction and economic development of the African continent. Particularly in Zambia, fish is considered one of the contributors to agriculture output. Fish supply in Zambia is dominated by capture fisheries . Even though it is of such great importance, profitability and determinants of profitability of capture fisheries is not known. Capture fisheries is also facing a challenge of decreasing supply against a growing demand. Part of the supply decline has been attributed to post harvest losses. There is less information of post-harvest losses of capture fisheries, where they occur in the value chain and what factors affect levels of post-harvest losses. This study examined profitability, post-harvest losses and factors influencing profitability and post-harvest losses. Specifically, the study assessed profitability of fishery enterprise to different actors of the value chain, quantified post-harvest losses affecting different actors along the value chain and determined factors affecting profitability and post-harvest lossed. The study used several approaches. It used gross margin analysis to determine profitability at key nodes of the fish value chain and used Ward and Jeffries approach to determine levels of post-harvest losses. The study also used regression models to assess factors affecting profitability and post-harvest loss. Translog profit function was used to quantify effect of various factors on gross margins. Multiple linear regression was used to assess factors influencing post-harvest loss as cost of loss. The study used data collected from 359 respondents through personal interviews using a pre-tested questionnaire. The study was conducted in Liyoyelo, Marana, Matula, Tangatanga, Nebubela and Liabwa from Mongu and Senanga districts. The districts have fishers, processors and traders. The study found that fishing and processing is a male dominated task while trading is a female dominated task. The results show that all three fish value chain nodes are profitable but fishing is more profitable. The study also found that post-harvest losses occur at all nodes of the value chain but there are higher chances of occurrence at processor node. Though this was the case, traders lose more in terms of percentage weight and in monetary value. The translog profit function results revealed that age, price of capital and price of materials affect profitability. The translog profit function also showed that an interaction of price of capital and price of transport, price of labor and price of transport and price of labor and price of materials influence levels of profitability. Multiple linear regression showed that cost of loss is influenced by experience, price of capital and fish group. the study concluded that fish related activities are profitable. It also concluded that post-harvest losses accur at all nodes of the value chain with trader node experiencing highest levels of percentage physical loss and quality loss. Profitability at trader node was determined by price of capital; price of materials; squared price of capital; squared price of labor; squared price of transport; interaction of price of capital and price of materials; interaction of price of labor and price of transport; interaction of price of labor and price of materials; and age. Post-harvest losses at trader node are affected by price of capital , age and form in which fish is sold. The implications of the findings are that profitability can be enhanced by capacity building in variable cost management and pricing to ensure profit maximization. Targeting high value markets to sell fish also improve profitability. Post-harvest losses can be reduced through improved processing and handling methods. Finally, further studies should be done to assess factors affecting profitability and post-harvest losses at fisher and processor nodes inorder to create full understanding of the value chain

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ACRONYMS

NEPAD	New Economic Partnership for African Development
CAADP	Comprehensive African Agricultural Development Programme
EFLAM	Exploratory Fish Loss Assessment Method
LT	Load Tracking
QLAM	Questionnaire Loss Assessment Method

CHAPTER 1

INTRODUCTION

1.1 Background

Capture fisheries have great social and economic value in Africa. It is a source of livelihood for fishers, processors and traders. It contributes directly to the economy through foreign exchange and revenue to government through taxes and fishing agreements (Graaf & Garibaldi, 2014). It is a major source of protein to more than 200 million people (30%) of the African population (Bene, 2011). In Sub-Saharan Africa and parts of Asia, more than 1 billion poor people obtain most of their average per capita intake of animal protein from fish. Fish represents 18% of total animal protein consumption and 9% of the total animal energy intake (Beveridge, *et al*., 2013).

New Economic Partnership for African Development (NEPAD) through Comprehensive African Agricultural Development Programme (CAADP) considers capture fisheries as a contributor to agricultural development in Africa (Bene, 2011). It recognizes that capture fisheries contribute to food security, poverty reduction and economic development of the African continent (Akande & Diei-Ouadi, 2010). In spite of the benefits accrued from capture fisheries in Africa, profitability and its determinants are not known. Capture fisheries also faces a challenge of widening gap between an increasing demand and a dwindling supply which has been attributed to poor post-harvest loss control among other factors (Akande & Diei-Ouadi, 2010; Kumolu-Johnson & Ndimele, 2011).

Fish is susceptible to post harvest damage. Post-harvest damage can be in form of physical damage or spoilage. Rough handling of fish leads to physical damage while poor hygiene and sanitation conditions facilitate accelerated spoilage (Kumolu-Johnson,*et al*., 2010). High temperature, improper processing, storing and distribution of fish are some of the factors that make fish prone to physical damage (Yola & Timothy, 2012). Physical damage and spoilage result in reduction in market price leading to financial losses or in extreme cases throwing away of the fish.

Fish losses are classified into physical, quality, nutritional and loss due to market forces (Kumolu-Johnson & Ndimele, 2011). Physical losses are when fish is completely lost from the value chain and is not utilised. This is caused by spoilage, insect attack, being eaten by animals, oversupply leading to discarding, theft or are associated with trash fish. Quality losses occur due to spoilage, insect attack and physical damage, but the fish are not lost from the value-chain, rather they are sold for a lower price. These losses also result in financial loss as there is difference between the optimum value of fish or fish product if no deterioration had occurred and the actual value the fish that is sold for a sub-optimal price due to spoilage. Loss due to market forces is when forces of supply and demand lead to reduction in price of fish. Fish also undergo nutritional change primarily as a result of over processing. These changes are associated biochemical changes in the flesh of the fish that result in spoilage (Ward & Jeffries, 2000).

Post-harvest losses occur at all stages of the value chain. It is estimated that approximately 10% in weight of the world fish maybe lost due to poor post-harvest handling and 70% of the total losses are loss in quality; and this figure is thought to be higher in small scale fisheries. Physical losses tend to be low but are more likely to occur when there is an oversupply of fish at landings sites where there insufficient demand or preservation and processing capacity. High losses of dried fish tend to be recorded during rainy seasons due to inclement weather conditions(Akande & Diei-Ouadi, 2010).

The level of post-harvest fish losses is influenced by several factors. Time lapse between harvest and reaching the final consumer which is determined by distance from origin and mode of transport used, affect levels of post-harvest loss. Post-harvest are also determined by physical characteristics such as size of the fish which depends on specie and form of preservation. Other factors influencing loss are selling price of fish; frequency of loading and offloading; temperature and fishing gear used (Nowsad, 2010; Yola & Timothy, 2012).

Fisheries is important to the national economy of Zambia through employment creation and food production (Mudenda, 2007). The fisheries sector in Zambia is dominated by artisanal or capture fisheries (Musumali,*et al*., 2008; Longley et al., 2014) . Fishing is done in the three major basins; Zambezi, Luapula and Tanganyika with Zambezi as the largest (Mwima & Mandima, 2005). Zambezi basin covers Kafue, Kariba, Lukanga, Upper Zambezi, Lower Zambezi, Itezhi-Tezhi and Luwashi fisheries (Musumali, *et al.* , 2009).

Barotse flood plain is part of upper Zambezi Basin. Barotse floodplain covers 550,000 hectares and has a population of 250,000 people (Cole, Puskur, & Rajaratnam, 2015). Barotse floodplain capture fisheries supports 300,000 people from western province and other areas (Mwima & Mandima, 2005). The plain offers an important source of income and food to households living around the floodplain. In a year, the flood plain yields approximately 6000-7000 tons (Tweddle, 2010). There is less documentation on fisheries business and post-harvest management in Barotse floodplain.

1.2 Statement of the problem

Capture fisheries is a source of income and cheap protein to large populations. Despite such importance, profitability is not known (Musumali,*et al*, 2009). Lack of information on profitability has led to undervaluing of the fisheries sector, its efficiency and contribution to agriculture (Tunde, *et al.*, 2015; Motaleb,*et al*., 2013).

Capture fisheries in Africa also faces a problem of declining supply against growing demand of fish. A 20% fall in per capita supply is anticipated, aggravating what is already the lowest regional supply in the world (World Bank, 2013). Addressing post-harvest losses and mismanagement, which together result in annual losses of $2 to $5 billion in Africa (Bene, 2011), offers an important means to address the issue. One of the constraints to reducing losses is the lack of information on how much loss occurs along the post-harvest fish value chain, how profitable different nodes of fish value chains are in light of the losses and the extent to which a wide range of factors affect profitability and post-harvest loss.

1.3 Objectives

1.3.1 Main Objective

The main objective of the study was to develop a quantitative and qualitative understanding of profit margins and post-harvest losses at major nodes in fish value chains associated with the Barotse floodplain.

1.3.2 Specific Objectives

- To assess profitability of fishery enterprises to different actors at nodes of the post fish value chain;
- To quantify post-harvest fish losses affecting different actors along nodes of fish value chain;
- To determine factors leading to profitability and fish post-harvest losses.

1.4 Research Questions

The study will answer the following questions:

- How profitable is the fish enterprise to various players of the post-harvest fish value chain associated with Barotse floodplain?
- Who incurs post-harvest fish losses along the value chain associated with Barotse Floodplain?
- What determines levels of profitability and post-harvest fish losses along the fish value chain associated with Barotse Floodplain?

1.5 Justification

In Zambia, the role of fish is recognized in the National Development Plan (2013 - 2016), where improvements in governance and management of resources and in value chains and markets are identified as key to sector development needed to meet an estimated 40,000 tons shortfall in supply (Zambia, 2011; Longley, *et a*l., 2014). Fish and fisheries are also included in the CAADP and are expected to maximize their contribution to the target 6% annual agriculture productivity growth rate.

This study respond to policies that are in play in Zambia and will also provide a comprehensive account of loss level along the post-harvest fish value chain in Barotse plain, Zambia. It will provide a guide for areas of focus when developing technologies that reduce fish post-harvest losses. This can improve incomes for players in the value chain. Considering that no research has been done on profitability and post-harvest loss of artisanal fisheries in Zambia, the study provides empirical evidence on profitability, post-harvest losses and factors that affect profitability and fish post-harvest losses.

1.6 Scope

This study focused on capture fisheries in Barotse floodplain of Zambia. Respondents were individuals involved in fishing, processing and trading as permanent residents of Liabwa, Liyoyelo, Matula, Tangatanga, Marana and Nebubela. Questions asked were based on the last time the respondent went fishing, processed fish or traded fish. Focus was placed on fish groups not specific species as species within a fish group were not so different from each other in term of preference on the market and market price. Respondents were only involved in one of the activities and not a combination of fish related activities.

1.7 Limitations

The study faced a few limitations that may have affected the study. Research was done in a different country than that of the researcher. The area has different language and culture. The researcher had to use an interpreter to probe for clarifications and respond to questions. The study was also affected by seasonality. Data was collected at peak season not low season because of time limitations.

1.8 Organization of the Research Project

This research project report is organized into five chapters. Chapter 1 introduces the study, states the problem, objectives, research questions, scope of the study and limitations. Chapter 2 reviews previous studies, methodologies and findings. Chapter 2 also explains the concept that the study has been based on. Chapter 3 describes research methodology adopted in this study, a study design, description of the study area, data collection procedures and analytical techniques. Chapter 4 presents the results and discusses the study findings. Finally, summary of the findings, conclusion and recommendation are presented in Chapter 5.

CHAPTER 2

LITERATURE REVIEW

2.1 Conceptual framework

The study was understood from an economic efficiency concept. Economic efficiency has been defined as the ability of a business entity to obtain maximum output from a specified input. It was also defined as the ability to get minimum input to produce an output (Chandrasekar & Gopal, 2015). Efficiency is achieved at a point when marginal benefits are equal to marginal cost. In other words, a business entity should minimize its cost of production for a given output (Frantz, 2015).

Other than the known costs of production that need to be minimized, a business entity dealing with perishable goods like fish incur costs in form of post-harvest losses. Post-harvest losses occur at any point between harvest and final consumer and most often the cost is borne by the seller. In order to achieve profit maximization goals, such business entities need to minimize post-harvest losses as a cost of loss.

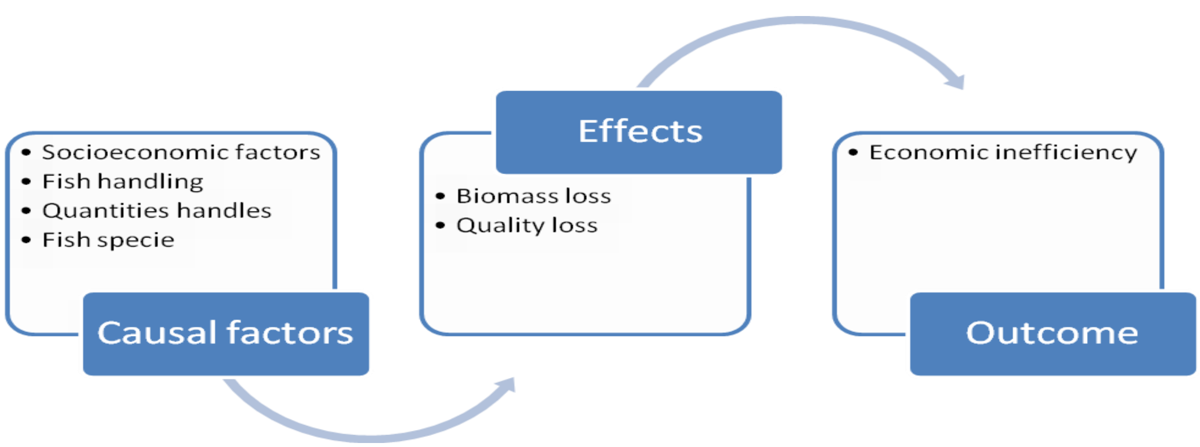

Figure 2.1 Post Harvest Economic Efficiency

Economic inefficiency can occur as a result of post-harvest losses. Post-harvest losses affect output of a business entity resulting into a scenario where marginal revenue is less than marginal cost hence causing low profitability (Goldsmith *et al*., 2015). Post-harvest losses are categorized into biomass loss, loss in quality and nutritional losses. This study focused on biomass and quality losses because they have direct effect on revenue generated from an investment.

Biomass losses are situations where fish is completely lost in the value chain through spoilage, insect attack, being eaten by animals, oversupply leading to deterioration causing discarding, theft or trash fish. Quality losses is change in biochemical and microbial level causing deterioration (Nowsad, 2010). Quality loss was assessed using the difference between potential value of fish or fish product if no deterioration had occurred and the actual value the fish is sold at after spoilage (Ward & Jeffries, 2000). Biomass and quality loss are expressed as percentage and in monetary terms. Post-harvest losses can be reduced by understanding factors that influence levels of loss.

Several independent factors affect cost of loss depending on the fish related activity an individual or business entity in involved in. This study focused mainly of factors that affect cost of loss at trader node. Post-harvest loss as cost of loss is affected by socio economic factors such as age, gender and education of people involved in fish related activities. Losses are affected by handling methods such as form of processing, type of packaging and mode of transport used. Quantity traded, storage period and time taken to reach market also influence levels of loss (Akande & Diei-Ouadi, 2010).

This study sought to assess profitability and quantify post-harvest losses as a means to bring economic efficiency and maximum profits. In order to minimize post-harvest losses, the study also sought to understand the extent to which various factors influence post-harvest loss.

2.2 Profitability of fisheries sector

Fisheries are a relatively cheap source of protein and income in Africa (Beveridge *et al*., 2013). Fisheries sector is divided into capture or artisanal fisheries and aquaculture with capture fisheries taking the large share of fish supply (Mwima & Mandima, 2005). According to Okeke-Agulu (2012), aquaculture is a profitable business. Profitability can be assessed using net farm income. Net farm income is the difference between total revenue and total costs. This approach was more relevant to aquaculture because fixed costs are easily estimated. Agbon, *et al*., (2013) agrees with Okeke-Agulu that fish trading is a profitable enterprise that can be a sufficient source of household income. According to Jatto, *et al.*, (2013), a farmer's interest in fish farming is positively influenced by how much income is generated.

Profitability of fisheries is affected by different factors. Different approaches have been used to assess extent at which several factors affect profitability. Okeke-Agulu (2012) assessed factors affecting profitability of Catfish in aquaculture using profit function approach. This approach used maximum variable profit as a measure of profitability which is affected by price of output, price of feed, price of fingerlings, price of labor and drugs or veterinary services. The study concluded that all variable costs affect variable profits except labor costs. Profit function approach is a less flexible approach to estimating factors affecting profitability. The approach assumes a single factor effect on profit but does not measure effect of interaction of factors.

2.3 Fish post-harvest losses

Fish is a highly perishable commodity and prone to damage as soon as it is harvested (Yola & Timothy, 2012). Fish can be damaged on landing, processing, exchanging of hands, and transportation leading to loss of the fish physically, nutritionally and quality wise and eventually translating to financial loss (Ward & Jeffries, 2000). Such losses are defined as fish post-harvest losses. Post-harvest losses occur at all stages of the value chain. Approximately 10% in weight of the world fish is lost due to poor post-harvest handling and higher is small scale fisheries (Akande & Diei-Ouadi, 2010).

2.4 Types of post-harvest fish loss

Fish loss can take various forms. According to Nowsad (2010), fish losses can be quantitative or qualitative. Quantitative losses occur due to mass killing during harvest, injury to the fish when harvesting, disease attack on the fish, glut catch, insect or rodent attack, damage due to processing, transportation, storage and changes in market forces and loss due to bad rumor. Qualitative losses are due to loss of nutrients in the fish, drip loss, use of illegal drugs and pesticides and spoilage due to bacteria, oxidation and autolysis. This categorization of losses lumps together several other types of losses that can be studied independently.

The broad categories of qualitative and quantitative losses can be broken down in a more pragmatic way into physical, quality, nutritional and losses due to market forces (Kumolu-Johnson & Ndimele, 2011;Ward & Jeffries, 2000). Physical losses are a complete loss of fish within the value chain. These losses are caused by insect attack, being eaten by animals, oversupply leading to deterioration causing discarding, theft or trash fish. On the other hand, quality losses is change in biochemical and microbial levels (Nowsad, 2010) causing spoilage and a difference between potential value of fish or fish product and the actual value the fish is sold at after spoilage. Fish also undergo nutritional losses which are caused by over processing that lead to loss of necessary nutrients and presence of other chemicals that make the fish unfit for human consumption. Loss due to market forces are reduction in price due to demand and supply leading to a loss of income (Ward & Jeffries, 2000).

According to Kumolu (2011), based on the Ward and Jeffries categorization found that 70% of the total losses are loss in quality. Loss of quality leads to reduced price which translates to losses economically. Physical losses seldom exceed 5% except in the main fishing season (20%). Higher losses are recorded during the rainy season due less sunlight.

2.5 Methods of assessing fish post-harvest losses

Post-harvest fish losses can be assessed using different methods. According to Nowsad (2010), fish loss can be assessed by looking at quality. Biochemical and microbial levels will determine the quality of fish which becomes evident by the appearance, feel and smell of the fish. In order to determine the quality of fish, test of biochemical deterioration, microbial levels and sensory based assessment can be employed. Biochemical deterioration is assessed through checking levels of true protein, non-protein nitrogen, total volatile base nitrogen, protein moisture, crude ash, peroxide value and thiobarbituric acid value and comparing them to required levels per specie. Microbial deterioration is investigated through bacterial count of fish muscle. Sensory based fish loss assessment tool is then used to determine quality of fish based on characteristics. Sensory based approach is mainly aimed at checking freshness of fish at different levels of the fish distribution chain. The sensory assessment is analyzed through categorization into sensory defect points according to each fish species. The defect points are then used to compute quality loss index expressed as a percent at each point in the distribution channel.

Sensory based approach was used when estimating quality losses in fresh or wet fish. Its application in estimating quality in dried, smoked or salted fish is not known. When fish is processed, appearance, texture and smell of the fish changes making it a challenge to use senses in determining quality. In most cases quality is subjective. A different approach might be through buyers' willingness to pay for a particular product. This may capture a buyer's use of senses in selecting and pricing a product. Most buyers of fish on the market base their price on personal opinion and preference.

Sensory based techniques do not adequately account for fish that is not utilized in the post-harvest value chain (physical losses). It describes the different quality points based on sense of sight and touch. This might define quality levels. But it may not account for fish that is eaten by animals, stolen or thrown away as trash fish.

Losses in fish may also be determined through mechanical, instrumental and laboratory chemical methods (Nowsad, 2010). These methods are time consuming and expensive. Considering that fish is highly perishable and needs less time in moving from fisher to final consumer, this approach may not be appropriate.

According to Akande and Diei-Ouadi (2010), post-harvest fish losses can be assessed using three methods: Exploratory Fish Loss Assessment Method (EFLAM), Load Tracking (LT) and Questionnaire Loss Assessment Method (QLAM). EFLAM is used as a participatory qualitative method of identifying where loss occurs and who is affected. Load tracking is used to quantify and support findings of the EFLAM through determining biomass losses associated with fishing, landing, icing, processing and other stages of the marketing and distribution chain. LT can also be used to determine the effectiveness of loss reduction interventions. Questionnaire loss assessment method is used as a final step to determine type of fish losses, why the losses occur and identification of key variables that affect fish loss levels. This is adapted from the Ward and Jeffries (2000) approach to post harvest fish loss assessment. Results are expressed as weight, proportion or monetary terms. This approach is ideal for any type of fish, different processing methods and can express physical, financial and marketing post-harvest fish loss.

The Ward and Jeffries (2000) is a more accommodative tool in determining physical and quality losses for different forms of processed fish. It bases quality on best price deducting price received for fish. This allows for buyer quality preference. It allows for triangulation of findings from several approaches to reach a better and well informed conclusion. It also identifies where the losses occur and potential variables that may influence post-harvest loss levels but does not estimate to what extent the potential variables affect loss levels. It quantifies physical loss in fish through the difference in mass between quantity bought and quantity sold with consideration of various processing methods.

This study used the Ward and Jeffries (2000) approach to estimating fish post-harvest losses at each node of the key post-harvest fish value chain but will go further to identify and quantify how the potential factors influence loss levels. It used the EFLAM and QLAM to estimate physical and quality losses along the key post-harvest fish value chain.

2.6 Factors leading to fish loss

Literature on determinants of post-harvest fish losses is very scanty. However literature is available on factors that lead to losses of perishable agriculture commodities such as tomatoes and research that makes mention of a list of potential factors that may lead to post harvest losses in fresh fish.

The level of post-harvest losses varies from one individual to another. It is therefore pertinent that there is an understanding of factors that may cause changes in post-harvest loss levels. Studies have shown that levels of post-harvest losses in general and fish losses specifically may depend on socio demographic factors and other exogenous factors (Addo et al., 2015; Nowsad, 2010; Akande & Diei-Ouadi, 2010).

Addo *et al*., (2015) examined determinants of losses along tomato value chains. The study established that socio demographic factors such as age, gender, literacy levels are important in loss level determination. Age affects the size, strength and quality of labor force used in an enterprise. Literacy levels affect the level of skills, participation and innovativeness of an individual in managing, developing and adopting new technologies. Nowsad, (2010) agrees with Addo *et al*, (2015) that gender is important is post-harvest losses. Gender affects division of labor, asset ownership and decision making in a business enterprise such as fisheries.

Post-harvest loss levels are also affected by exogenous factors such as distance from origin of fish to the final market, time taken to reach market, mode of transport, mode of processing and packaging. According to Nowsad (2010), distance to market affects the freshness of the fish if sold fresh. The longer the distance the more likely that fish will lose quality. The mode of transport will affect form of packaging and time it takes to reach the market. The way fish is packaged may cause breakage or injury to the skin or heat accumulation making it susceptible to spoilage (Akande & Diei-Ouadi, 2010).

Akande and Diei-Ouadi (2010) considered seasonality, species and processing as important in fish post-harvest losses. Seasonality of fish affects demand-supply relationship which in turn affects price of fish causing loss due to market forces. Species handled affects choice of processing methods used. Species also affect size of fish caught causing quick deterioration if fish is small and slower deterioration if fish is relatively big. Previous studies also identifies that the form in which fish is sold will also affect levels of loss. Fresh fish is likely to spoil quicker than dried, smoked or salted fish.

CHAPTER 3

METHODOLOGY

3.1 Theoretical Framework

The market for fish is assumed to be perfectly competitive where everyone can participate and the one selling is a price taker. Consider a fish value chain player that seeks to maximize profit (Hussain, 2012). In order to maximize profit, the individual makes a scale decision. That is, selection of minimum cost input factor combination and then deciding what quantity to supply to make maximum profit.

Thus the individual profit maximization problem can be expressed as a function

$$\max(py - C(w,r,y)) \qquad \text{(Eq. 3.1)}$$

Where

p is selling price

y is quantity traded

C is cost which is a function of factors wages and rent

To optimize, first order conditions must be fulfilled where

$$[y]: p = {dC(w,r,y)}/{dy} \qquad \text{(Eq. 3.2)}$$

This implies that the optimal scale decision of an individual is a function of factor price r and w and output price p. This can also be written as

$$y^* = y^*(w, r, p) \quad \text{(Eq. 3.3)}$$

To maximize profit, an individual should have fish whose marginal revenue will equal to marginal cost (Abdou & El-batran, 2015). Since the fish traders are price takers, marginal revenue will be constant and equal to output price.

Decision on what quantity to supply is affected by how much post-harvest losses a value chain player is faced with. Losses reduce the output that reaches the market even though cost was incurred. This makes loss a cost to the value chain player that reduces the marginal revenue. Hence loss has to be considered when deciding the quantity to supply if an individual has an objective of maximizing profit.

3.2 Research Design

A study design is important in deciding the method of data collection and analysis to be used. The study used a survey design because it studied what was taking place at present not an induced situation to observe change.

3.3 Study Area

Mongu and Senanga are two districts of Barotse Floodplain along the Zambezi River. People in the two districts majorly in the fishing camps are involved in fish related activities and agriculture. The floodplain lies north western of Zambia and southward of Angola with a population of 225,000. It covers four districts (Mongu, Limulunga, Senanga and Kalabo) and an area of 550,000 hectares of land. 280,000 hectares is arable agricultural land. The two districts were selected basing on proximity to the researcher and ease of transportation.

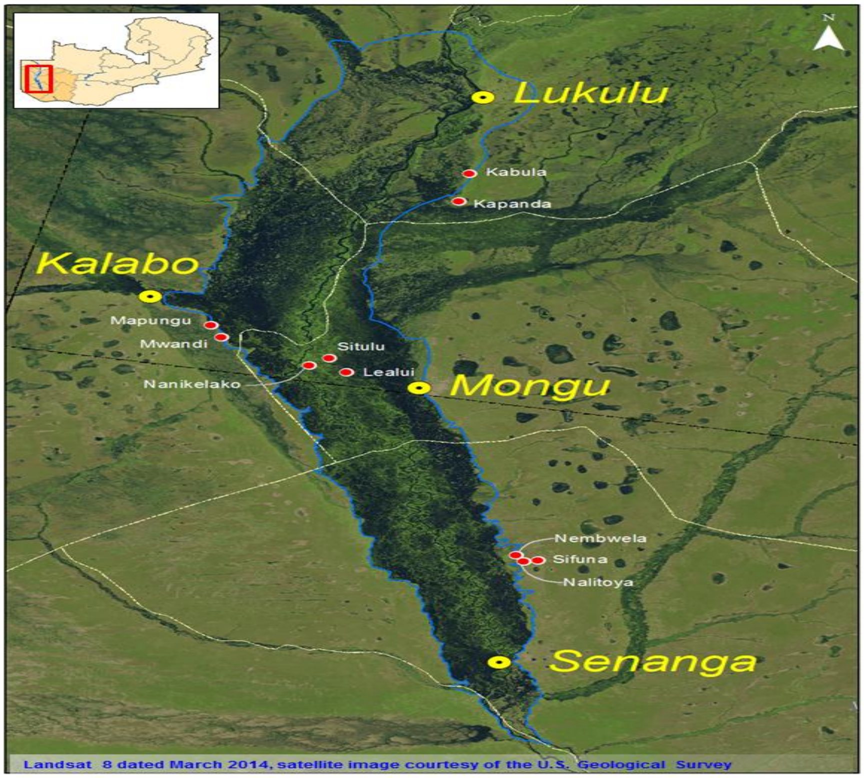

Figure 3.1 Map of Barotse floodplain (Adapted from Longley, et al.,(2015))

3.4 Target Population

The study was done in Western province in Zambia. The study targeted fishers, processors and traders from Mongu and Senanga district of Barotse floodplain. The study involved both men and women that are currently involved in fish related activities. The target population was individuals that were permanent residents and temporary residents of the fishing camps.

3.5 Sampling Procedure

The study used data collected from individuals in Mongu and Senanga districts on the floodplain of Western province in Zambia. Population of the two districts is dynamic because individuals move in and out due to the rise and fall of water levels.

A multistage sampling technique was used to select a statistically representative sample from the population. Firstly, 6 fishing camps and 2 district markets were selected purposively based on proximity to the provincial centre and levels of fish related activity levels. A list of individuals that are involved in fish related activities was collected from WorldFish offices in Mongu. Each fishing camp was randomly sampled as shown in table 3.1. From the 379 who were sampled, 359 were willing to participate in the study.

Table 3.1 Sampling Frame

DISTRICT	CAMP	POPULATION	SAMPLE
	Liabwa (Mukakani)	27	26
	Liyoyelo	75	63
Mongu	Nebubela	34	31
	Tangatanga	41	36
	Matula	41	36
Senanga	Marana	42	37
	Mongu Main Market		69
	Senanga Main Market		81

Some samples were also drawn from district markets. Population of people doing fish related activities in the district markets was not known and was assumed to be indefinite. A sample of 384 was divided among the 2 district markets where a sample of 192 was drawn from each district. Out of the sampled, 69 were available for interview in Mongu and 81 in Senanga district markets.

Data was collected through personal interviews using a pre-tested questionnaire (see annex 1). The individual involved in fish related activities was selected for interview in each case. The data collected included respondent characteristics and fish business characteristics.

3.6 Data Collection

The study combined quantitative and qualitative research approaches. The research applied three research tools: Exploratory Fish Loss Assessment (EFLAM), Questionnaire Fish Loss Assessment (QLAM) and Gross Margin Analysis.

The Exploratory Fish Loss Assessment Method (EFLAM) generated qualitative and indicative quantitative data using rapid and participatory rural appraisal methods. A checklist was used to guide the participatory method. The information gathered through the use of the EFLAM tool was used to generate ideas for loss in a participatory manner, and also plan the next stage in the research process, the Questionnaire Loss Assessment Method (QLAM) (Ward & Jeffries, 2000).

The Questionnaire Loss Assessment Method (QLAM) used a formal questionnaire survey approach to interview sampled fishermen, traders and processors in the selected project sites. It provided quantitative data to assess key aspects of post-harvest fish losses, including who is experiencing different types of loss, reasons for loss, the financial value of loss, frequency of loss, and other variables which affect loss including differences in loss affecting men and women. The QLAM tool also collected information about the livelihood activities (Ward & Jeffries, 2000).

Gross margin was used as an approach to understand the relationship between sales revenue and cost structure (Malaiyandi, *et al*., 2010; Alegbeleye, 2013). Gross margin analysis used a formal questionnaire to interview men and women involved in fishing, processing and trading in the selected communities. It used information on price received for a particular unit of fish, amount of fish traded on the market, amount of fish consumed by the household and by products. This gave gross revenue or value of production. It also provided information on cost material inputs, family labor and hired labor as variable costs.

3.7 Pilot Test

The questionnaire was pre tested in a fishing camp close to Liabwa in Mongu. The pretest helped in refining questions and estimating how much time a questionnaire will take. The questionnaire was administered to 10 respondents before the tool was administered to the intended sample. The pretest assisted in coding of local units of measure and developing of a list of conventional measures of the local units.

3.9 Empirical Analysis used to address the Objectives

Objective 1: Profitability of Fishery Enterprises to Different Actors at Key Nodes of the Post-Harvest Fish Value Chain.

In order to assess profitability, gross margin analysis was used. Data was based on the last consignment a value chain actor caught, processed or traded in. Data on how much fish was sold and at what price it was sold was collected. Fish consumed was valued in order to quantify the gross income. Cost of taking the fish from one node of the fish value chain to the next that is specific to the fish enterprise and varies according to quantity was collected. Gross margins were calculated per respondent using the formula given as:

$$GM = P_Y Y - \sum P_i X_i \qquad \text{(Eq. 3.4)}$$

GM- gross margin in Zambian Kwacha per respondent

P_Y – price of fish per Kg

Y- Quantity of output in Kgs

P_i –price for each i^{th} input unit

X_i – quantity of input used/respondent unit for each i^{th} input

Objective 2: Post-Harvest Fish Losses

Post-harvest fish loss assessment was used to quantify physical and quality losses. Both types of losses have a loss in monetary value. Data on total quantity of fish caught, processed or traded and lost was collected. The best and low prices offered and their quantities respectively were collected. According to Ward and Jeffries (2000), fish postharvest losses was quantified using the formula below:

Physical loss (%) = (e/d)* 100……………………………………….(Eq. 3.5)

Physical loss value (ZMW) = e * a…………………………………..(Eq. 3.6)

Quality loss weight (%) = (c/d)*100…………………………………(Eq. 3.7)

Quality loss value (ZMW) = c * (a – b) ……………………………...(Eq. 3.8)

Total value loss (ZMW) = physical loss value+ Quality loss value…….(Eq. 3.9)

Where:

a. selling price – good quality

b. selling price – poor quality

c. quantity sold for low price

d. total quantity

e. quantity thrown away – physical

Objective 3: Factors Influencing Profitability and Fish Loss

Factors Influencing Profitability of Capture Fisheries Trade

Factors affecting profitability were assessed using translog profit function and Cobb Douglas (Biddle, 2012). A translog profit function and Cobb Douglas were employed to quantify how different cost related variables and socio-economic factors affect gross margins of traders. A translog function has a flexible functional form that approximates a twice differentiable function without placing restriction on production technology (Verdugo, 2007). It allows testing of restrictions imposed by other cost functions. Translog profit functions can be used to address several issues in economics. They look at impact of factor price on the total cost or profit, economies of scale, scope and density and technology on cost structure.

In a general form according to Chong (2015) Cobb Douglas function can be written as:

$$Y = \beta_0 X_1^{\beta_1} X_2^{\beta_2} \quad \text{……………………………………………………………..(Eq. 3.10)}$$

Where Y is output

X_1 and X_2 are input factors

β_1 and β_2 are output elasticity

From the Cobb Douglas production function we can derive a profit function as

$$\Pi = \beta_0 PX_1^{\beta_1} PX_2^{\beta_2} \qquad \text{(Eq. 3.11)}$$

Where Π is gross margin/Kg

PX_1 and PX_2 are price of input factors

β_1 and β_2 are price elasticity

The function is linearized to:

$$\text{Log}\pi = log\beta_0 + \beta_1 logX_1 + \beta_2 \log X_2 + \varepsilon \qquad \text{(Eq. 3.12)}$$

According to Daglish,*et al.*, (2015), translog profit function using Shephard's Lemma approach is given as:

$$\ln \Pi^* = \alpha_0 + \sum \alpha_j lnpw^* + \gamma_y \ln py + {}^1/_2 \gamma_{yy} \ln py^2 + {}^1/_2 \sum_j \sum_k \beta_{jk} \ln pw_j^* lnpw_k^* + \sum \gamma_{jy} lnpw_j^* \ln py + v \qquad \text{(Eq. 3.13)}$$

Where

Π^* is profit

α_0 is the intercept

β_{jk} , γ_y ,γ_{yy} , γ_{jy} are parameters to be estimated

pw and py are input price factors

The implicit function form of the above is given as:

Gross Margin=f(price of capital, price of labor, price of transport, price of storage, price of materials, sex of respondent, age, education level, experience, fish group, fish form)

This model used data collected from traders only.

Factors Affecting Post-Harvest Loss at Trader Node

Post-harvest losses were presented in monetary value and as a percentage. In order to assess factors affecting post-harvest loss, loss in monetary value was used in form of cost of loss. Cost of loss was used because it is a good representation of biomass or physical loss and quality loss.

A multiple linear regression model was used to quantify how factors influence cost of loss. According to Adepoju (2014), linear regression is generally stated as :

$y_i = \alpha + \beta x_i + \varepsilon_i$ ....(Eq. 3.14)

Where y_i is the dependent variable

α is constant

β is coefficient of independent variable

x_i is independent variable

The implicit function form of the above is given as:

Cost of loss=f(quantity traded, age, gender, experience, education level, specie, price of capital, price of labor, price of storage, price of transport, price of materials, form of processing,)+ ε

Definition of variables in the Translog Profit Model and Multiple Linear Regression and how they were measured:

Price of capital: This is a continuous variable and was measured in Zambian kwacha per kilogram. This was expected to affect gross margin and cost of loss. An increase in price of capital would reduce gross margins of traders. An increase in price of capital would increase cost of loss.

Price of labor: This is a continuous variable and was measured as wage rate in Zambian kwacha per day. Price of labor was expected to have a negative effect on gross margin and a positive effect on cost of loss. An increase in price of labor would result in a decrease in gross margin and an increase in cost of loss.

Price of transport: This is a continuous variable and was measured in Zambian kwacha per trip. Price of transport was a continuous variable which would affect gross margin negatively and affect cost of loss positively. If there was an increase in price of transport, gross margin would reduce and cost of loss would increase.

Price of storage: This is a continuous variable and was measured in Zambian kwacha per day. Increase in price of storage was expected to have a negative effect on gross margins and have a positive effect on cost of loss.

Price of materials: This is a continuous variable and was measured as Zambian kwacha per item. Change in price of materials was expected to have a negative influence on gross margin and a positive influence of cost of loss. This meant that an increase in price of materials would lead to a reduction in gross margins and an increase in cost of loss.

Quantity traded: This is a continuous variable that was measured in kilograms. This was expected to affect level of care when handling fish from one point to another. It was expected that the more the quantity, the higher the cost of loss. Since the range of quantity was expected to vary widely, the data was transformed. In order to make a meaningful comparison, the variable was linearized by taking natural logarithms.

Age: It is a continuous variable that was measured in years. It was expected to have an effect on knowledge of handling and trading of fish. It was expected that the older a person gets, the more knowledgeable they are in managing their source of income. Knowledge in business management is not solely based on age but also education and exposure.

Gender: It is a dummy variable that took values of 0 and 1. 1 is for male and 0 for female. It was expected that men would have less losses and more profits as compared to women because they have more time allocated to business while women need to balance between home management and business. Men can also access distant markets while women participation in distant markets is minimal hence may experience high losses. This was measured as a dummy variable where males would be assessed using females as reference point.

Experience (period a person has been involved in trading): This is a continuous variable that was measured in years. It was expected that the longer a person has traded in fish, the more they would be able to do business efficiently and minimize post-harvest losses. New entrants were expected to incur more losses and less profit. This variable was linearized by taking a natural logarithm transformation.

Education: This is a form of capital needed in trading. It is human capital measured by number of years schooling (grade). It was expected that the more years an individual spends in school, the more they gather skill and knowledge in management and the less the losses. The less educated a person is, the higher the likelihood of experiencing fish losses. It was expected that those who spend more time in school may be more innovative and high risk takers in business.

Fish groups: This is a categorical variable that was used as identification of common fish groups by numbers. 1=bream (lipapati), 2=bulldog (nembele), 3=catfish (ndombe), 4=tiger fish (ngweshi). It was expected that the fish groups would determine size of fish. The smaller the fish, the more prone it is to loss. Fish group was measured as dummy variable where bulldog, catfish and tiger fish's effect was assessed using bream as a reference point.

Form of processing: This is a categorical variable. It was expected that the form of processing would determine amount of moisture in the fish and in turn lead to loss. High moisture processing exposes fish to bacteria that cause spoilage if not properly handled. On the other hand, very low moisture content such as drying leads to easy breakage. 1= fresh fish, 2=sundried, 3=smoked and 4=salted. This was measured as a dummy variable where effect of sundried, smoked and salted fish of cost of loss and profitability was assessed using fresh fish as a reference.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Socioeconomic Characteristics of Respondents

Fishing is seasonal in Barotse floodplain. The fishing season is determined by floods. Fishing is at its peak from the month of August to November. During this time, flood water recedes and fish are confined in small pools of water. Low season is from the month of March to June. This period is when water levels are high and fish have more area to move hence difficulty in catching fish. The Department of Fisheries enforces a closed fishing season from early December to end February the following year to allow fish to breed. The closed months are also rainy season when the water rises in the floodplain.

Seasonality of fishing influenced price fluctuations of fish and settlement patterns. At peak season, price of fish was relatively low due to abundance of fish on the market. During this period, some temporary fishing camps were established. Price of fish was relatively high over low season due to scarcity and high demand of fish. Over this period, households moved to upland areas.

Descriptive statistics in table 4.1 and 4.2 show a summary of socioeconomic characteristics of fishers, processors and traders. Table 4.1 shows that average age and experience of respondents varied between the three activities. Processors had the highest average age of 40.53 years and more experience of an average of 14.26 years. Traders had the lowest average age of 33.97 and the least experienced with an average of 7.6 years. Overall, respondent's average age was 36.51 and an average overall experience of 10.44 years. A pairwise comparison of age and experience was significantly different between fishers-trader and processor trader ($p<0.05$). Considering age and experience, respondents were within productive age and had reasonable knowledge of fish related activity.

Table 4.1 also shows that fishers, processors and traders had attended school to as high as grade 7, revealing that they had basic literacy and numeracy skills that are relevant for business. There was less variability in grades of the three groups. Statistical pairwise comparison of the mean grade showed that grade is statistically not different across the groups(p< 0.05).

Table 4.1 Summary of Socioeconomic Characteristics of Respondents

VARIABLE	FISHERS		PROCESSORS		TRADERS		OVERALL	
	Mean	St dev	Mean	St dev	Mean	St dev	Mean	St dev
Age of respondent	38.56	13.17	40.53	9.62	33.97	10.03	36.51	11.38
Grade of respondent(No. of years in school)	6.63	3.09	7.33	2.5	7.34	2.66	7.11	2.8
Experience (in years)	13.52	11.09	14.26	10.45	7.6	7.27	10.44	9.58

The study interviewed 49.3% (177) females and 50.7% (182) males. There were variations in the way sexes participated in fish related activities. Table 4.2 shows that fishing was a male dominated job with 96.58% (113) males. Processing was done by more men than women with 70% (35) males and 30% (15) females. On the other hand, trading was done more by women with 82.29% (158) representation than men with 17.71 %(34). Pairwise comparison of sex or gender was also statistically different across all the three groups (p<0.05).

Fishers, processors and traders had a mixed pattern of residence. Some of them were permanent residents of the areas they were interviewed in while others were not permanent residents but just came to the area to do fish related activities. Table 4.2 shows that overall, 90.99% of the respondents were permanent residents of the area while 9% came to do various fish related activities. The pattern of residence was not different across the three groups .

The three groups handled different fish groups. The areas had seven different fish groups that were commonly caught, processed and traded. Table 4.2 shows that fishers, processors and traders handled bream, bulldog fish, catfish, tiger fish, barb fish and squeaker. The most common fish group handled by fishers, processors and traders was bream with a representation of 88.89%, 58% and 84.9% respectively.

Fish was sold in four forms; fresh, sundried, smoked and salted. Table 4.2 shows that fishers handle fresh fish only. Processors handled sundried, smoked and salted fish with 86% of the consignment in smoked form. Traders handled fresh, sundried, smoked and very few respondents handle salted fish. 43.75% of the fish handled by traders was in fresh form. The differences were statistically different ($p<0.05$). According to the exploratory fish loss assessment, the choice of which form of fish to handle depended on season and the target market preference.

Table 4.2: Frequency Table of Socio-economic Characteristics of Respondents

		FISHER		**PROCESSOR**		**TRADER**	
Variable		**Frequency**	**%**	**Frequency**	**%**	**Frequency**	**%**
Gender	Female	4	3.42	15	30	158	82.29
	Male	113	96.58	35	70	34	17.71
Residence	Permanent	99	84.62	45	90	183	95.21
	Temporary	18	15.38	5	10	9	4.69
Fish Groups	Bream	104	88.89	29	58	163	84.9
	Bulldog	9	7.69	17	34	20	10.4
	Catfish	1	0.85	2	4	9	9
	Tiger	1	0.85	2	4		
	Barb	1	0.85				
	Squeaker	1	0.85				
Form	Fresh	116	100			84	43.75
	Sundried			6	12	57	29.69
	Smoked			43	86	50	26.04
	Salted			1	2	1	0.52

4.2 Gross Margin Analysis

Table 4.3 and 4.4 indicate cost distribution in fishing, processing and trading. Table 4.3 shows that the variable cost composition of the three fish related activities are different. Fishers did not have transport as a cost component. This was because fishers sold fish on the water to passing customers and processors while processors and traders travel to district markets to reach better markets.

Table 4.3 Cost Distribution of Fish Related Activities per Day

	FISHERS	PROCESSORS	TRADERS
	-------------ZMW-------------		
Mean Direct costs			
Buying fish		422.27	523.05
Firewood		7.75	
Insecticides		22.58	22.58
Transport		20	43.19
Packaging material			12.43
Storage			16.11
Accommodation			24.09
Fish levies			6.44
Market levies			10.31
Association fees			9.75
Mean Labor Costs			
Setting and pulling nets	43.52		
Removing fish from net	35.54		
Splitting, cleaning and scaling		14.23	
Drying		10.56	
Smoking		21.11	
Grading		9.5	10.14
Packaging/stockpiling		16.11	12.05
Lifting, loading and offloading			14.44
Total Variable Cost (TVC)	**79.06**	**544.11**	**704.58**

Table 4.4 shows percentage distribution of costs incurred by different fish related activities. The main cost component for processors and traders was capital cost i.e. cost of buying fish for processing and/or for resale. Capital cost accounted for 77.6% for fishers and 74.25% for traders. Unlike for fishers, the major cost component was labor. Traders had other cost components such as packaging material, storage, accommodation and market levies that were not incurred by fishers and processors. This was because traders target district and distant market which have better prices and more costs.

Table 4.4 Percentage Cost Distribution of Fish Related Activities per Day

	FISHERS	**PROCESSORS**	**TRADERS**
	% cost of TVC	% cost of TVC	% cost of TVC
Mean Direct costs			
Buying fish		77.6	74.25
Firewood		1.42	
Insecticides		4.15	3.2
Transport		3.68	6.13
Packaging material			1.76
Storage			2.29
Accommodation			3.42
Fish levies			0.91
Market levies			1.46
Association fees			1.38
Mean Labor Costs			
Setting and pulling nets	55.05		
Removing fish from net	44.95		
Splitting, cleaning and scaling		2.62	
Drying		1.94	
Smoking		3.88	
Grading		1.75	1.44
Packaging/stockpiling		2.96	1.71
Lifting, loading and offloading			2.05
Total Variable Cost (TVC)	**100**	**100**	**100**

Table 4.5 shows a summary of efficiency measures of the three fish related activities. On average, fishers handle higher quantities of fish than processors and traders in a day. This might have been due to the handling of fresh fish only while processors handle other forms of fish other than fresh. Traders handled all forms of fish. This may also have caused variations in price of fish per kilogram.

Fishers, processors and traders had significantly different gross margins ($p<0.05$). This was attributed to the differences in fish forms and cost components involved in the fish related activity. Fishers had one major cost component and only handled fresh fish which weighs more. In a day, fishers had the highest gross margin of ZMW 10.32 per kilogram while processors had the smallest margin of ZMW 1.73 per kilogram.

Table 4.5 Efficiency Measure of Fish Related Activities per Day

Item	Fisher	Processor	Trader
Average Yield(Kg)	35.64	15.55	26.43
Average Price (ZMW/Kg)	12.54	36.72	33.91
Average Gross Output (ZMW/Individual)	446.93	571	896.24
Average Gross Margin (ZMW/Individual)	367.87	26.89	191.66
Average Gross Margin (ZMW/Kg)	10.32	1.73	7.25

4.3 Post-Harvest Fish Loss

Post-harvest loss occurred at all levels of the value chain but at different magnitudes. Figure 4.1 shows a summary of quantities of fish handled, lost and sold at a low price by fishers, processors and traders. Processors handled more fish as compared to fishers and traders. This was because processors camp out in the fishing camps for some period of time buying and processing fish till they reach a desired quantity. The quantity bought was very high as compared to the quantity sold. There was a loss in weight due to processing that causes a gap between the weight of fish that was bought and the weight of fish sold. Fishers and traders did not face such disparities because they buy and sell fish in one form.

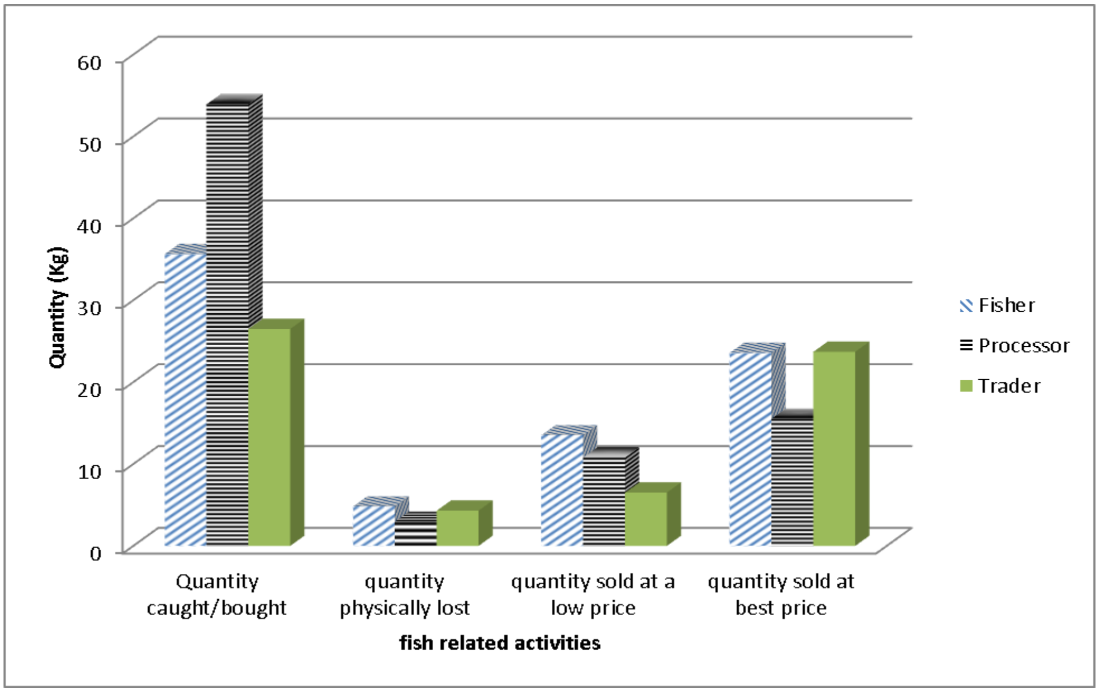

Figure 4.1 Average Quantities of Fish Handled, Physically Lost and Sold at a Low Price

Table 4.6 show that processor node had a high chance of facing biomass loss (58% probability) as compared to traders' node (26.04% probability) and fishers' node (5.98%). In terms of weight, processors lost small quantities of fish than traders and fishers lost almost the same quantity of fish entirely from the value chain. Part of the quantity caught or bought was sold on the market at a low price. Traders had a high chance of selling fish at a low price (24.48% probability) as compared to fishers and processors. Fishers and processors had a probability of 15.38% and 16% of selling fish at a low price respectively. In terms of quantities, fishers sold more fish at a low price than processors and traders.

Table 4.6 also shows the major causes of biomass loss/ physical loss at different nodes of the value chain. Physical or biomass loss at fishers' node was largely caused by predation with a representation of 71.43% while losses at processor and trader node were caused by breakage with 38.10% and 60% respectively.

Table 4.6 Frequency of Post-Harvest Loss

		FISHER		PROCESSOR		TRADER	
Variable		**Freq**	**%**	**Freq**	**%**	**Freq**	**%**
Biomass Fish Loss	Yes	7	5.98	21	42	50	26.04
	No	110	94.02	29	58	142	73.96
Fish Sold at Low Price	Yes	18	15.38	7	14	47	24.48
	No	109	93.16	43	86	145	75.52
Cause of biomass loss	Spoilt	1	14.29	6	28.57	12	24
	Predation	5	71.43	6	28.57	5	10
	Breakage	1	14.29	8	38.10	30	60
	Soakage			2	9.52	3	6

Figure 4.2 shows a percentage representation of fish that was entirely lost and fish that was sold at a low price. The percentages were expressed in relation to the quantity caught or bought. Trader lost the highest percentage on average (20% of the quantity bought entirely from the value chain). Traders also had a high percentage of fish bought sold at a low price (34%). This meant that a trader lost 20Kg of fish out of every 100Kg and sold 34Kg out of every 100Kg at a low price. This agrees with other studies that concluded that losses are prominent at trader level (Motaleb, *et al* , 2013).

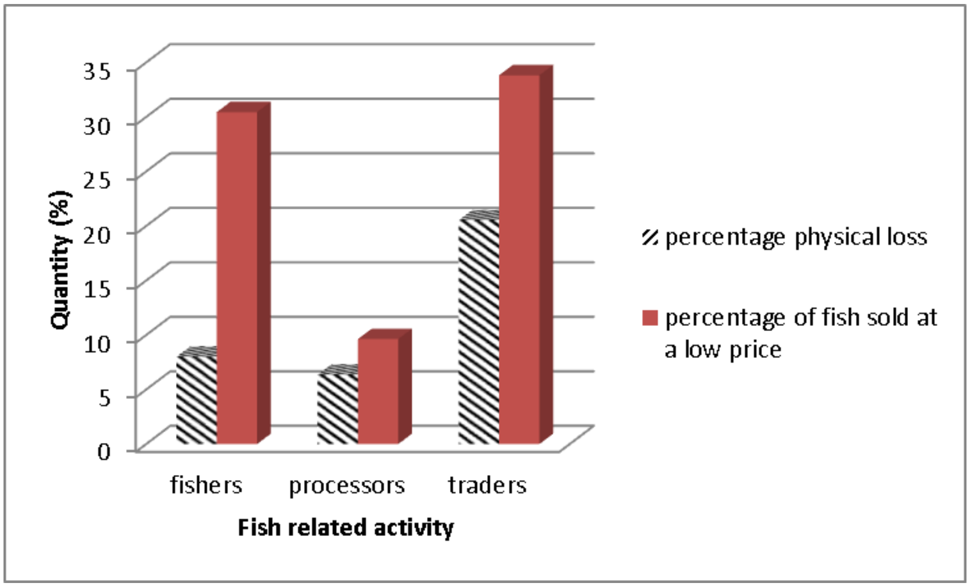

Figure 4.2 Average Percentage Quantity Lost Physically and Sold at a Low Price

Post harvest fish losses were also expressed in monetary value. This was the money that was lost through physical (biomass) loss and money that was lost due to reduction in price of fish. Figure 4.2 shows the average amount of money that was lost by fishers, processors and traders within a day. On average, traders lost more money through biomass loss and through reduction in price. Processors lost the least amount of money due to biomass loss or reduction in price.

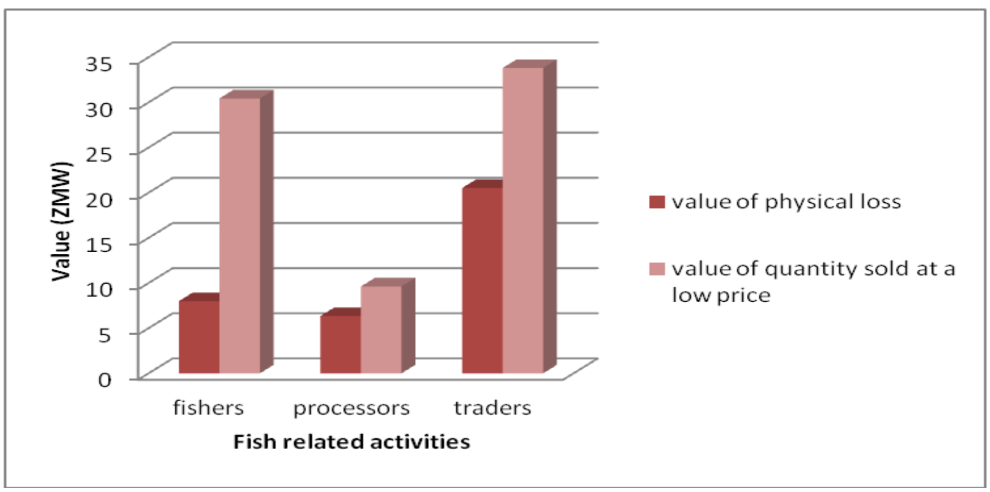

Figure 4.3 Average Monetary Value of Fish Lost Physically and Fish Sold at a Low Price

Even though graphs show differences in quantities, percentages and monetary value of loss, a statistical analysis was employed to see if the differences were significant. Table 4.7 shows a summary of analysis of variance of post-harvest losses across fishers, processors and traders. Physical loss or biomass loss value varied across the three fish related activities. Though there was variation in the individual quantities, the comparison of biomass loss across fishers, processors and traders was insignificant. On the contrary, biomass loss as a percentage is significantly different across the three groups. A Bonferroni post hoc test showed that trader node was significantly different ($p < 0.01$)from fisher and processor node. This was due to differences shown in the graphical representation of percentage loss which was based on quantities bought. On the overall, all groups lost an average of 28.2% in form of physical loss. This agrees with results of Akande & Diei-Ouadi (2010) that showed post-harvest loss at 30%.

Table 4.7 ANOVA Summary of Post-Harvest Loss

	Mean	**F- value**	**Sig**
Physical loss (%)	28.2	11.126	0.000[a]
Value of physical loss(ZMW)	12.87	1.119	0.332
Quality loss in weight (%)	60.61	4.286	0.018[b]
Value of quality loss(ZMW)	98.03	1.473	0.236
Total value loss(ZMW)	35.47	13.139	0.000[a]

Note: [a] implies significant at $p<0.01$, [b] implies significant at $p<0.05$ and [c] implies significant at $p<0.1$

Table 4.7 also shows value of quality loss. Quality loss across the three groups ranged from ZMW2.27 to ZMW 66.09. Across fishers, processors and traders, the value of quality loss was not significantly different. Even though value of quality loss was not significantly different across the three groups, percentage quality loss was significantly different ($p < 0.05$). Total value loss was at ZMW 35.47 on average. This was significantly different between fishers, processors and traders ($p<0.01$). A post hoc Bonferroni test showed fisher node was significantly different from the trader and processor node ($p< 0.05$) .

4.4 Factors Influencing Profitability

The extent at which various independent factors influence profitability of fish trading was quantified using a Cobb Douglas and translog profit function. The results are presented in table 4.8.

Table 4.8 Estimates of Translog Profit Function and Cobb Douglas Function

		Translog profit function		Cobb Douglas	
Dependent Variable= Gross Margin	**Parameter**	**Coefficient**	**p-value**	**Coefficient**	**p-value**
Constant	α_0	-1.74	0.051[c]	-0.47	0.48
Normalized price of capital	α_1	2.02	0.032[b]	0.5	0.002[a]
Normalized price of labor	α_2	-0.33	0.555	-0.09	0.341
Normalized price of transport	α_3	0.72	0.184	-0.13	0.232
Normalized price of storage	α_4	0.29	0.969	0.17	0.212
Normalized price of material	α_5	1.01	0.056[c]	0.13	0.172
Normalized price of capital squared	α_6	-1.51	0.073[c]		
Normalized price of labor squared	α_7	-0.62	0.045[b]		
Normalized price of transport squared	α_8	-0.46	0.058[c]		
Normalized price of storage squared	α_9	0.06	0.909		
Normalized price of material squared	α_{10}	-0.179	0.574		
Normalized price of capital X normalized price of labour	α_{11}	0.44	0.311		
Normalized price of capital X normalized price of transport	α_{12}	-0.4	0.381		
Normalized price of capital X normalized price of storage	α_{13}	-0.003	0.996		
Normalized price of capital X normalized price of material	α_{14}	-0.84	0.052[c]		
Normalized price of labor X normalized price of transport	α_{15}	-0.8	0.015[b]		
Normalized price of labor X normalized price of storage	α_{16}	0.18	0.679		
Normalized price of labor X normalized price of material	α_{17}	0.93	0.005[a]		
Normalized price of transport X normalized price	α_{18}	0.66	0.101		

of storage					
Normalized price of transport X normalized price of material	α_{19}	0.21	0.465		
Normalized price of storage X normalized price of material	α_{20}	-0.34	0.243		
Sex of respondent (Male)	α_{21}	0.15	173	0.14	0.201
Normalized age	α_{22}	0.74	0.064[b]	0.45	0.255
Normalized Experience	α_{23}	-0.16	0.238	-0.2	0.14
Education					
primary	α_{24}	0.14	0.546	0.02	0.926
secondary	α_{25}	0.12	0.611	0.0055	0.981
Fish group					
bulldog	α_{26}	-0.19	0.155	-0.17	0.219
catfish	α_{27}	-0.43	0.029[b]	-0.53	0.007[a]
Fish form					
sundried	α_{28}	-0.068	0.54	-0.017	0.875
smoked	α_{29}	0.017	0.877	0.07	0.5
log likelihood			-137.5	-154.17	
AIC			1.76	1.77	
BIC			-799.4	-869.31	

Note: [a] implies significant at p<0.01, [b] implies significant at p<0.05 and [c] implies significant at p<0.1

In order to decide which model fits the data best, a likelihood ratio test was conducted. It tested the null hypothesis whether additional variables in the Cobb Douglas function were equal to zero against the alternative hypothesis that additional variables to the Translog Profit function were equal to zero. The Likelihood Ratio Test gave the following results:

LR chi2 (15) = 33.30

Prob> Chi2 = 0.0043

Based on the results we reject the null hypothesis that stated that additional variables to the Cobb Douglas function were equal to zero. Translog profit function was a better fit for the data than Cobb Douglas function. Considering this, the results of the fitted translog function are presented in table 4.9 and interpretations have been discussed below.

Various socio-economic factors were tested to check whether they affect gross margins of fish traders in Barotse floodplain. Table 4.9 shows that age had an influence on gross margins ($p<0.1$). A year increase in age resulted in a less than proportional increase in gross margin (ZMW 0.72). From the descriptive statistics in table 4.1, traders had an average age of 33.97 years. This was within the productive age group and is more willing to explore different markets. This result collaborates with Jatto, *et al*., (2013) that age affects decision making. Table 4.9 also shows that catfish will have a smaller reduction in gross margin as compared to bream fish group ($p< 0.05$). This is because catfish has a target market based on religious beliefs than bream which is consumed widely in Zambia.

Table 4.9 shows that profitability in Barotse flood plain is significantly affected by price of capital. The results show that a unit increase in price of capital per kilogram will lead to an increase in gross margin by 2.35 ($p<0.01$). It also shows a positive relationship between cost of materials and gross margin ($p< 0.1$). A unit increase in price of material led to an increase in gross margin by 0.92. Though these findings are unexpected in theory, they are in agreement with Okeke-Agulu (2012) which reveal that cost of capital and other costs significantly affect profitability positively except labour which was not significant. Using the law of diminishing marginal returns, as price of capital and price of materials increases, profits will increase till it reaches level of maximum output (Stephen, 2015). Afterwards, profitability will begin to decline as price of capital and price of materials increase. This was best illustrated using squared prices of capital and labour.

Table 4.9 also shows that squared estimates of price of capital, price of labor and price of transport have a significant negative effect on gross margin ($p < 0.05$). These results are according to theoretical expectations of quadratic terms of the respective variables. They also agree with finding of Tanko (2015) which revealed that squared estimates of price of labor has a negative influence of profitability as a measure of efficiency. This was attributed to increase in costs causing a reduction in efficiency.

Table 4.9 also shows effect of an interaction of independent variables on gross margin. The interactions explain partial responses of gross margin to various independent variables. The results show that an interaction of price of capital and price of material has a significant negative effect on gross margin ($p<0.1$). A unit change in the interaction of price of labor and price of transport will result in reduction in gross margin by 0.75 ($p<0.05$), but a unit change in the interaction of price of labor and price of materials will cause an increase in gross margin by 0.94 ($p<0.01$). Other economic factors like cost of transport and cost of storage do not influence gross margins. Squared transport and storage costs or an interaction does not affect gross margins.

Table 4.9 Estimates of Fitted Translog Profit Function

Dependent Variable= Gross Margin	Parameter	Coefficient	p-value
Constant	α_0	-1.67[b]	0.035
Normalized price of capital	α_1	2.35[a]	0.008
Normalized price of labor	α_2	-0.34	0.53
Normalized price of transport	α_3	0.61	0.25
Normalized price of storage	α_4	-0.03	0.971
Normalized price of material	α_5	0.92[c]	0.077
Normalized price of capital squared	α_6	-1.78[b]	0.023
Normalized price of labor squared	α_7	-0.68[b]	0.024
Normalized price of transport squared	α_8	-0.48	0.044
Normalized price of storage squared	α_9	0.017[b]	0.974
Normalized price of material squared	α_{10}	-0.24	0.424
Normalized price of capital X normalized price of labour	α_{11}	0.47	0.261
Normalized price of capital X normalized price of transport	α_{12}	-0.33	0.463
Normalized price of capital X normalized price of storage	α_{13}	0.039	0.945
Normalized price of capital X normalized price of material	α_{14}	-0.8[c]	0.059
Normalized price of labor X normalized price of transport	α_{15}	-0.75[b]	0.018
Normalized price of labor X normalized price of storage	α_{16}	0.19	0.653
Normalized price of labor X normalized price of material	α_{17}	0.96[a]	0.003
Normalized price of transport X normalized price of storage	α_{18}	0.59	0.129
Normalized price of transport X normalized price of material	α_{19}	0.26	0.354
Normalized price of storage X normalized price of material	α_{20}	-0.33	0.242
Normalized age	α_{21}	0.73[c]	0.06
Normalized Experience	α_{22}	-0.19	0.138
Fish group			
bulldog	α_{23}	-0.17	0.186
catfish	α_{24}	-0.47[b]	0.014
log likelihood			-139.46
AIC			1.71
BIC			-829.95

Note: [a] implies significant at p<0.01, [b] implies significant at p<0.05 and [c] implies significant at p<0.1

4.5 Factors Influencing Cost of Loss

In order to examine factors influencing loss, cost of loss was used in a multiple linear regression. Multiple linear regression was used because cost of loss is a continuous dependent variable. Hence the discussion following is based on multiple linear regression of cost of loss function. The results of the fitted multiple linear regression is shown in Table 4.10.

Table 4.10 shows a significant relationship between price of capital and cost of loss ($p<0.01$). A unit increase in price of capital will result in a reduction in cost of loss by 0.67. Considering that it is a cost function modeling inefficiency, an increase in price will cause an increase in cost. The higher the cost, the more careful a trader is in handling goods. These findings collaborate with Tanko (2015) which revealed that the higher the investment, the lower the inefficiency. Table 4.10 also shows cost of labor, storage and transport does not have a significant influence on cost of loss. This is because as cost components, storage, transport and materials take a small percentage as compared to cost of capital.

Table 4.10 also shows that cost of loss is significantly affected by form in which fish is sold. The results show that sundried fish will have higher cost of loss by 0.3 than fresh fish ($p<0.05$). It also shows that smoked fish will have higher cost of loss by 0.58 than fresh fish ($p<0.05$). This may be due to differences in storage time of fresh fish, dried and smoked fish. All forms of fish experience post-harvest loss which agrees with results from Yola &Timothy (2012) which concluded that fresh and dried fish experience post-harvest loss.

Socioeconomic factors like sex of respondent, age and education level had no statistically significant influence on cost of loss. This is in partial agreement with results from a study conducted by Basavaraja, *et al*., (2007) on economic analysis of post-harvest losses in food grains. In the grain study, education had a significant positive influence on post-harvest loss but age does not affect post-harvest losses. In fish post-harvest loss assessment, changes in sex of respondent and education level will not cause a statistical significant change in cost of loss. On the other hand, experience has a significant influence on cost of loss. The more experienced a trader is, the higher the cost of loss. These findings contradict Tanko (2015) where experience did not have a significant influence on inefficiency.

Table 4.10 Factors Influencing Cost of Loss: Multiple Linear Regression Model

Dependent Variable= Cost of Loss		Parameter	Coefficient	p-value
Constant		α_0	1.47	0.038[b]
Normalized price of capital		α_1	-0.67	0.000[a]
Normalized price of labor		α_2	-0.059	0.796
Normalized price of transport		α_3	0.13	0.359
Normalized price of storage		α_4	0.035	0.803
Normalized price of material		α_5	-0.04	0.828
Normalized quantity traded		α_6	-0.01	0.922
Normalized age		α_7	-0.32	0.384
Normalized experience		α_8	0.35	0.041[b]
Sex of respondent				
	Male	α_9	0.12	0.394
Education level				
	Primary	α_{10}	-0.08	0.474
Fish groups				
	Bulldog	α_{11}	-0.0008	0.997
	Catfish	α_{12}	0.135	0.541
Fish Form				
	Sundried	α_{13}	0.298	0.048[b]
	Smoked	α_{14}	0.583	0.001[b]
Number of Observations		71		
Prob> F		0.0000		
R-square		0.548		
Adjusted R square		0.435		

Note: [a] implies significant at p<0.01, [b] implies significant at p<0.05 and [c] implies significant at p<0.1

CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

Fisheries are a major source of income to fishers, processors and traders. Concerns about undervalued benefits and post-harvest losses have stimulated scholars to study capture and artisanal fisheries. Thus profitability and post-harvest loss levels have implications on livelihoods, food security and contribution of fisheries to agricultural output.

This study assessed profitability, pots-harvest losses and determinants of profitability and post-harvest levels. Gross margin analysis was used to determine profitability of capture fisheries at key nodes of the value chain. Regression techniques were employed to quantify determinants of profitability and determinants of post-harvest losses at trader node of the fish value chain. In particular, translog profit function was used to assess how factors influencing profitability and multiple linear regression model was used to assess factors affecting cost of loss as a measure of post-harvest loss. The study used descriptive analysis to assess profitability and post-harvest losses at key nodes of the fish value chain. The study used data collected from 359 respondents in Mongu and Senanga districts. The areas were purposively selected to represent fish related activities in Barotse floodplain.

The study found that fishing is a seasonal activity. Each of the fish related activities have specific gender dominance with fishing and processing as a male dominated task and trading as a female dominated task. The study found that fishing, processing and trading are profitable businesses but fishing is more profitable. It also found that capital is a major cost component for processors and traders while labor in a major cost component for fishers.

The study found that post-harvest losses occur at all nodes of the post-harvest losses. It also found that processors have more chances of facing biomass losses than fishers and traders but traders have high chances of having quality losses. At fisher node, biomass losses are due to predation while at processor and trader node, most of the biomass losses are due to breakage. In terms of percentage and monetary value, traders lose more than fishers and traders.

The study further found that profitability of capture fisheries trading is influenced by price of capital; price of materials; squared price of capital; squared squared price of labor; squared price of materials; an interaction of price of capital and price of material; price of labor and price of transport and price of labor and price of material. It also found age is the only social factor that affects profitability. In particular, the study found that catfish are likely to make less profit than bream fish.

Lastly, the study found that price of capital and experience explains cost of post-harvest loss. Specifically, the study found that price of capital has an inverse relationship with cost of post-harvest loss. It also found that experience has a direct relationship with cost of post-harvest loss.

5.2 Conclusions

The study concluded that capture fisheries, processing and trading is a profitable business. Levels of profitability are determined by price of capital; price of materials; squared price of capital; squared squared price of labor; squared price of materials; an interaction of price of capital and price of material; price of labor and price of transport and price of labor and price of material. The study also concluded that trader node losses the highest percentage of its consignment and revenue due to physical and quality losses. Though trader node experiences more losses, processors have high chances of experiencing post-harvest losses. The study lastly concluded that levels of post-harvest loss at trader node are influenced by price of capital and years of experience.

5.3 Recommendations

The study findings indicate that capture fisheries is profitable but is affected by price of capital and price of materials. Profitability is also affected by an interaction of price of capital and price of materials; price of labor and price of transport; and price of labor and price of materials. There is need therefore to build capacity of traders on how to make capture fisheries trading efficient. Traders need to know how to manage variable costs particularly cost of capital and cost of materials to maximize profits. Traders can also target high value markets that are less sensitive to selling price changes. There is also need to build capacity of fishers, processors and traders on fish handling to reduce post-harvest losses. In particular, processors and traders need to package and transport the fish in a way that will not expose the fish to breakage.

5.4 Areas of Further Study

Since the study only looked at factors affecting profitability and post-harvest losses at trader node, there is need for further studies to assess factors affecting profitability and post-harvest loss and fisher and processor node. These studies should include seasonal effect on profitability and post-harvest losses. Seasonality nature of fish in the Barotse floodplain was suggested as one of the factors that affect profits and post-harvest losses. This will give a full understanding of every node of the post-harvest fish value chain.

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ANNEX 1

Informed Consent for Post-harvest loss assessment tool questionnaire for CULTIAF project

DUPLICATE: *Enumerator: Tear out this page, and leave it with the participant*

Informed Consent: *Before beginning the interview, it is necessary to introduce the respondent to the survey and obtain their consent to participate. Make it clear to them that their participation in the survey is voluntary. Please read the following statement in the language of interview:*

Thank you for the opportunity to speak with you. We are a research team from [DoF, UNZA, University of Malawi, WorldFish, Nono Enterprise]. We are conducting a survey to learn about fish-related activities, profitability and post-harvest losses in this area. If you would like to participate, we will ask you questions on fishing, trading, and processing activities; physical and economic losses; and fish sales, among other topics. These questions in total will take approximately 30 minutes to complete and your participation is entirely voluntary. If you agree to participate, you can choose to stop at any time or to skip any questions you do not want to answer. Your answers will be completely confidential.

We will also interview other people in your village or fishing camp. The information will help us inform the development of interventions that could be helpful to the people in this area. Do you have any questions about the study or what I have said? If in the future you have any questions regarding the study and the interview, or concerns or complaints we welcome you to contact your district fisheries officer [IN SENANGA, MONGU, NALOLO]. In addition you can contact the head of Ethics Review at [UNZA]. We will leave one copy of this form for you so that you will have record of this contact information and about the study.

Please ask the participants if they consent to the participation in the study (check one box):

Participant:				
	YES	☐	NO	☐

I ____________________________, the enumerator responsible for the interview taking place on __________________, 2015 certify that I have read the above statement to the participant and they have consented to the interview. I pledge to conduct this interview as indicated on instructions and inform my supervisor of any problems encountered during the interview process.

If the participant does not give consent to all of the data collection, stop the interview and inform your team leader. Team leaders will discuss the reason for this refusal and decide whether a partial data collection is possible for this participant.

Questionnaire Number……………………………..

POST HARVEST LOSS ASSESSMENT ALONG KEY FISH VALUE CHAIN ASSOCIATED WITH BAROTSE FLOODPLAIN

GENERAL INFORMATION

Start time	
Name of enumerator	
Date of interview	
District	
Village	
fishing camp	

RESPONDENTS INFORMATION

Name of respondent		
Sex of respondent	Male..... 1 Female . 0	
Years of schooling(grade)		
Age (e.g. 1950)		
Are you a permanent resident?	Yes……1 No……2	

1. Which of the following activities do you normally engage in this part of the season?

ACTIVITY	Tick the appropriate
Catching fish	
Processing fish	
Buying-Selling fish	

1B. how long have you been involved in these activities? …………**years**……….**months**

INSTRUCTIONS FOR FILLING THE QUESTIONNAIRE

- Questions refer to the **last time the respondent was involved in fishing, processing or buying and selling**
- **S,M,L** represent fish size as **Small, Medium and Large** respectively
- If the respondent went **fishing** and sold the fish fresh, fill **section B**
- If the respondent **bought fresh fish, processed it and sold, fill section C**
- If the respondent bought **either fresh fish or processed fish and sold, fill section D**
- On labor table, if respondent says family find out how much they would pay it they were using hired labor to do the task

SECTION B: FISHING INFORMATION

FISH HARVEST INFORMATION

B1.What type of fishing gear do you use? **Code** 1=gillnets 2=seine nets 3=spear 4=baskets 5=traps 6=longline 7=hook &line 6=other	B2. Which fish species did you catch in the past consignment? (*list the common one*) **Codes** 1 = lipapati 2 = nembele 3 = ndombe 4 = ngweshi 5=other		B3Quantity of fish caught **Unit Codes** 1 = 20Lbucket 2 = bafa 3= meda 4=basin 5=mukundi 6=piece 7= Other (specify)		B4. Quantity of fish consumed **Codes** 1 = 20Lbucket 2 = bafa 3= meda 4=basin 5=mukundi 6=piece 7= Other (specify)		B5.Quantity bartered/give away **Code** 1 = 20Lbucket 2 = bafa 3= meda 4=basin 5=mukundi 6=piece 7= Other (specify)		B6.Quantity processed **Code** 1 = 20Lbucket 2 = bafa 3= meda 4=basin 5=mukundi 6=piece 7= Other (specify)		Quantity lost **Code** 1 = 20Lbucket 2 = bafa 3= meda 4=basin 5=mukundi 6=piece 7= Other (specify)		Cause of loss **Code** 1=spoilt 2=theft 3=predation 4=breakage 5=soakage 6=other	B7. Quantity of fish sold fresh? **Unit Codes** 1 = 20Lbucket 2 = bafa 3= meda 4=basin 5=mukundi 6=piece 7= Other (specify)		B8. Price of fresh fish **Unit Codes** 1 = 20Lbucket 2 = bafa 3= meda 4=basin 5=mukundi 6=piece 7= Other (specify)		B9. Did you sell any fish at a low price? **Code** 1=yes 2=no	B10. Quantity of fish sold at a low price **Unit Codes** 1 = 20Lbucket 2 = bafa 3= meda 4=basin 5=mukundi 6=piece 7= Other (specify)		
			Qty	Unit	Qty	Unit	Qty	Unit	Qty	Unit	Qty	Unit		Qty	Unit	ZMK	Unit		Qty	Unit	Price/Unit
		S																			
		M																			
		L																			

NB: *lipapati covers mbufu, njinji, sewo and muu*

FISHERS

LABOUR COSTS FOR FISHERS (for last time he/she went fishing)

Activities	D1.Who does these activities? **Codes** 1=male 2=female 3=both	D2.Relationship **Codes** 1=family member 2=hired labour 3=other(specify)	D3.Mode of pay **Code** 1=cash 2=kind *If 1=kind, fill D4, if 2=kind fill D5*	D4.If cash, how much? **(ZMK)**	D5.If kind	
					Qty	**Units**
Setting and pulling nets						
Removing fish from nets						
Other (specify)						

SECTION C: PROCESSOR INFORMATION

PROCESSING INFORMATION

E1. Which fish species did you process in the past consignment? (*list the common one*) **Codes** 1 = lipapati 2 = nembele 3 = ndombe 4 = ngweshi 5=other		E2.How did you source fresh fish? **Code** 1=bought 2=from family member 3=own catch 4=other (specify)	E3.Quantity processed **Unit Codes** 1 = 20Lbucket 2 = bafa 3= meda 4=basin 5=mukundi 6=piece 7= Other (specify)		E4.**if Purchased**, price of fish/unit **Unit Codes** 1 = 20Lbucket 2 = bafa 3= meda 4=basin 5=mukundi 6=piece 7= Other (specify)		E5.Processing technique used **Codes** 1 = sun dried 2 = smoked 3=salting 4=frying 5 = Other (specify)	Quantity lost **Code** 1 = 20Lbucket 2 = bafa 3= meda 4=basin 5=mukundi 6=piece 7= Other (specify)		Cause of loss **Code** 1=spoilt 2=theft 3=predation 4=breakage/burnt 5=soakage 6=other	E6.Quantity sold **Unit Codes** 1 = 20Lbucket 2 = bafa 3= meda 4=basin 5=mukundi 6=piece 7= Other (specify)		E7.Selling price of fish **Unit Codes** 1 = 20Lbucket 2 = bafa 3= meda 4=basin 5=mukundi 6=piece 7= Other (specify)		E8.Did you sell fish at a low price? **Code** 1=yes 2=no	E9.If yes how much fish did you sell at a low price? **Unit Codes** 1 = 20Lbucket 2 = bafa 3= meda 4=basin 5=mukundi 6=piece 7= Other (specify)			E10. How did you use the rest of the fish? **Codes** 1=given away 2=consumption 3=bartered 4=other (specify)	E11.Quantity **Codes** 1 = 20Lbucket 2 = bafa 3= meda 4=basin 5=mukundi 6=piece 7= Other (specify)	
			Qty	Units	Unit	ZMK		Qty	Units		Qty	units	Units	ZMK		Qty	Unit	Price		Qty	ZMK
	S																				
	M																				
	L																				

NB: *lipapati covers mbufu, njinji, sewo and muu*

PROCESSING COSTS

		G1. Do you incur the following costs? **Code** 1=yes 2=no	G2. Cost **(ZMK)**	G3.How often do you incur these costs? **Code** 1=daily 2= once in a week 3= once a month 4=once a year 5=other(specify)
Packaging materials Specify…………………………………				
Firewood				
Preservation chemicals Specify……………………………….				
Transport	Boat/canoe			
	Bus			
	Taxi			
	Other (specify) ………………………			
Other (specify)				

PROCESSOR

PROCESSING LABOUR

Activities	H1.Who does these activities? **Codes** 1=male 2=female 3=both	H2.Relationship **Codes** 1=family member 2=hired labour 3=other(specify)	H3.Mode of pay **Code** 1=cash 2=kind	H4.If cash, how much? **(ZMK)**	H5.If in kind	
					Qty	Units
Splitting and cleaning, scaling						
Grading						
Drying						
Smoking						
Packaging /stockpiling						
Salting						
Frying						
Other (specify)						

TRADERS

SECTION D: BUYING AND SELLING

BUYING AND SELLING

I1.What type of trading do you do? **Codes** 1=retail 2= wholesale 3=both	I2.Which fish species did you sell in the past consignment? (*list the common one*) **Codes** 1 = lipapati 2 = nembele 3 = ndombe 4 = ngweshi 5=other		I4.How much fish did you buy/get? **Unit codes** 1 = 20Lbucket 2 = bafa 3= meda 4=basin 5=mukundi 6=piece 7= Other (specify)		I5.At what price did you buy the fish/unit? **Unit Codes** 1 = 20Lbucket 2 = bafa 3= meda 4=basin 5=mukundi 6=piece 7= Other (specify)	I6.Form in which fish was sold? **Codes** 1 = Fresh 2 = Sun dried 3 = Smoked 4=salted 5=fried 46= Other (specify)	I7.How much fish did you sell? **Unit Codes** 1 = 20Lbucket 2 = bafa 3= meda 4=basin 5=mukundi 6=piece 7= Other (specify)		I8.Selling price of fish/unit **Unit Codes** 1 = 20Lbucket 2 = bafa 3= meda 4=basin 5=mukundi 6=piece 7= Other (specify)		Quantity of fish lost **Code** 1 = 20Lbucket 2 = bafa 3= meda 4=basin 5=mukundi 6=piece 7= Other (specify)		Cause of loss **Code** 1=spoilt 2=theft 3=predation 4=breakage/burnt 5=soakage 6=other	I9.Did you sell fish at a low price? **Code** 1=yes 2=no	I10.If yes, how much fish did you sell at a low price? **Unit Codes** 1 = 20Lbucket 2 = bafa 3= meda 4=basin 5=mukundi 6=piece 7= Other (specify)		
			Qty	Unit	ZMK		Qty	Unit	Unit	ZMK	Qty	Units			Qty	Unit	Price
		S															
		M															
		L															

I13. Where do you buy fish? ……………………………………………………………………….

I14. Where did you sell your fish? ....

I15. How long does it take to travel to the market? ....**days**…………**hours**……………**minutes**

I16. How do you travel to the market? ....

I17. How do you package your fish? ....

I18. How long do you keep the fish before selling? ....**days**……………**hours**

I19.How long does it take to sell the fish? ....**days**………………**hours**

VARIABLE BUYING – SELLING COSTS

	Do you incur the following costs? **Codes** 1=yes 2=no	**Cost (ZMK)**	How often do you incur these costs? **Code** 1=daily 2= once in a week 3= once a month 4=once a year 5=other (specify)
Transport			
Packaging material			
Storage			
Accommodation			
Preservation chemicals Specify……………………………………………			
Market levies			
Fish levies			
Association fees			
Other			

TRADERS

TRADING LABOUR COSTS

Activities	**Who does these activities?** **Codes** 1=male 2=female 3=both	**Relationship** **Codes** 1=family member 2=hired labour 3=other(specify)	**Mode of pay** **Code** 1=cash 2=kind	**If cash, how much? (ZMK)**	**If kind**	
					Qty	**Units**
Packaging labor						
Grading and sorting						
Lifting /loading &offloading						
Other (specify)						

Interview end time:………. : ………

This is the end of the interview. Thank you for participating

ANNEX 2

	Mean Difference (I-J)						Standard. Error						Significance					
	Trader		Processor		Fisher		Trader		Processor		Fisher		Trader		Processor		Fisher	
	(J) ACTIVITY		(J) ACTIVITY		(J) ACTIVITY		(J) ACTIVITY		(J) ACTIVITY		(J) ACTIVITY		(J) ACTIVITY		(J) ACTIVITY		(J) ACTIVITY	
Dependent Variable	fisher	process	Fisher	Trader	process	trader	fisher	process	fisher	trader	process	trader	fisher	process	fisher	trader	process	trader
Gender	-.789*	-.523*	-.266*	.523*	.266*	.789*	.032	.071	.068	.071	.068	.032	.000	.000	.000	.000	.000	.000
Age	-4.23*	-6.22*	1.99	6.215*	-1.99	4.226*	1.43	1.6	1.84	1.6	1.842	1.43	.004	.000	.283	.000	.283	.004
Education (years)	.527	.105	.422	-.105	-.422	-.527	.351	.419	.460	.419	.460	.351	.134	.803	.361	.803	.361	.134
Residence	-.106	-0.52	-0.54	.052	.054	.106	.037	.046	.054	.046	.054	.037	.005	.257	.324	.257	.324	.005
Species	.437*	.054	.383*	-.054	-.383*	-.437*	.107	.171	.158	.171	.158	.107	.000	.754	.018	.754	.018	.000
Form of fish	.833*	-.067	.900*	.067	-.900*	-.833*	.060	.079	.052	.079	.052	.060	.000	.401	.000	.401	.000	.000
Experience	-5.93*	-6.598*	.67	6.596*	-.670	5.93*	1.18	1.59	1.83	1.591	1.83	1.183	.000	.000	.714	.000	.714	.000
Gross margins	-196.11*	-1097.82*	901.71*	1097.82*	-901.71*	196.11*	35.37	177.06	179.30	177.06	179.30	35.37	.000	.000	.000	.000	.000	.000
% biomass loss	9.3589*	10.97*	-1.606	-10.97*	1.606	-9.36*	2.486	2.01	1.87	2.01	1.868	2.49	.001	.000	.412	.000	.412	.001
Value of biomass loss	57.15	-.261	57.41	.261	-57.41	-57.15	20.03	21.22	18.74	21.22	18.74	20.03	.008	.990	.005	.990	.005	.008

%quality loss	**.07448**	**20.88***	**-20.80***	**-20.88***	**20.80***	**-.74**	**5.12**	**3.36**	**4.36**	**3.36**	**4.36**	**5.12**	**.988**	**.000**	**.000**	**.000**	**.000**	**.988**
Quality loss value	**28.38***	**-15.21**	**43.6**	**15.21**	**-43.6**	**-28.38***	**13.29**	**34.19**	**32.97**	**34.19**	**32.98**	**13.29**	**.037**	**.667**	**.224**	**.667**	**.224**	**.037**
Total value loss	**33.69***	**-30.46**	**64.14***	**30.46**	**-64.14***	**-33.69***	**6.91**	**16.41**	**15.17**	**16.41**	**15.17**	**6.91**	**.000**	**.068**	**.000**	**.068**	**.000**	**.000**