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Between the sun and fish are people: A socio-economic study of solar dryers for fish processing in Malawi

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Abstract

This study examined how the usage of solar tent dryers had improved the livelihoods of fish processors in Chipala and Vinthenga villages in Nkhotakota, Malawi. The study used the sustainable livelihoods framework to analyse the findings. A mixed methods research design was employed in the study. For the qualitative data, a thematic analysis was used; and for the quantitative data, inferential and descriptive statistics were used such as logit regression modelling and t-tests. The solar tent dryers have improved fish processing; however, the impact of the dryers is minimal and not well accounted for. Some key sustainability measures were lacking and therefore posed a threat to the continued use of the method. The logit regression model indicated that the location (village) of a fish processor was the only determining factor for participation in solar tent drying activities. Adoption increased as the fish processors realised that the method reduced their time and energy spent whilst processing fish. However, lack of space in the dryer meant that increases in adoption limited the impact of the dryer on income. Adoption was directly affected by poor governance; a top-down approach employed by different stakeholders. Women were involved in all activities in the fisheries value chain except for catching fish, which is restricted to men. Gender roles and perceptions affected the socio-economic status of fish processors, as gender equality was contextualised as a monetary responsibility shift to women who were involved in fish processing and other enterprise. All factors considered, the solar tent dryers have had insignificant impact on the livelihoods of fish processors. The project would have benefited from an interdisciplinary approach, where fish processors were the central focus of the intervention, to ensure that the outcome was sustainable livelihoods.

Key words: Lake Malawi, solar tent dryers, fish processing, sustainable livelihoods, governance, co-management, Nkhotakota

Declaration

I, Fundi Kayamba-Phiri, declare that this thesis is a result of my research investigations and findings. Sources of information other than my own have been acknowledged and a reference list has been appended. This work has not been previously submitted to any other university for award of any type of academic degree.

Signature……

Date……

To my parents,

Dennis and Edrinnie

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Abbreviations

BVC	Beach Village Committee
CABMACC	Capacity Building for Managing Climate Change in Malawi
CBNRM	Community-Based Natural Resource Management
EPA	Extension Planning Area
DFO	District Fisheries Officer
FGD	Focus Group Discussion
FP	Fish processor
LUANAR	Lilongwe University of Agriculture and Natural Resources
NGO	Nongovernmental organisation
OSD	Open sun drying
SEED Fish	Sustainable Environment and Enterprise Development for Climate Change Adaptation in Fisheries
SLA	Sustainable Livelihood Approach
SLF	Sustainable Livelihood Framework
TA	Traditional Authority
VH	Village Head
VNRMC	Village Natural Resource Management Committee

Exchange rates as of July 31st, 2017

1 US Dollar to Malawi Kwacha = 725

1 Norwegian Kroner to Malawi Kwacha = 92

BETWEEN THE SUN AND FISH ARE PEOPLE: A SOCIO-ECONOMIC STUDY OF SOLAR TENT DRYERS FOR FISH PROCESSING IN MALAWI

CHAPTER ONE: INTRODUCTION

1.1 Introduction

Lake Malawi is home to the largest number of fish species in the world, with an estimated around 1000 fish species, most of which are indigenous to Lake Malawi (MBERU, 2001). The lake has attracted tourists but most importantly, its fish has been a major source of protein for most of the population in Malawi, as fish has been the cheapest source of protein in the country (Matiya *et al,* 2005). Despite all the glory that the Lake attracts, fish populations are dwindling (USAID, 2015). Furthermore, there are post-harvest losses incurred. These changes have consequences for the country's fish industry, but also mainly those who depend on fish for their livelihood: fisherfolk. Thus, the livelihoods of fisherfolk form the basis of this investigation, more especially fish processors who are involved in all post-harvest activities.

Malawi is a south-eastern country in Africa with an estimated population of 17.2 million people (World Bank, 2016). Fisheries sustain the livelihoods of almost 10% of the population and represent 4% of the country's GDP (USAID, 2015). The total area of Malawi is 118 484km^2, with a total water area of 24 405km^2, which represents around 20% of the total area.

Globally, almost half a billion people earn their income through fisheries (Anon, 2011). Fisheries employ about 60,000 people in Malawi, but with over a half a million Malawians employed either directly or indirectly through fish processing and marketing, owning of fishing gear and repair (USAID, 2015). In the 1970s, individual fish consumption was estimated at 14kg/year; however, current estimates are at 5.6kg/year (USAID, 2015). One of the reasons for this is declining catches in some lakes such as Lake Chilwa in the southern region of Malawi.

The decline in fish consumption has been attributed to a number of reasons, including reduced fish populations due to overfishing, largely because of use of illegal gear and destructive fish gear (FAO, 2005). Another reason for this decline is due to post-harvest losses, owing to the nature of processing methods used or lack thereof, which reduce the possibilities for producers along the fish value chain to experience significant economic growth (Russell *et al*., 2008). In this respect, the commonly used processing methods are sun drying, parboiling, smoking and, recently, frying though about 60% of fisher folk do not process fish. Inefficiencies in the use of any of these processing methods tend to lead to the decline in fish sales as well as negatively affect the nutritional value of the fish and the environment. For instance, fish sun-dried along

the beach exposes it to airborne diseases, while smoked and fried fish contribute to deforestation as a lot of firewood is required for curing, which in turn leads to desertification, soil erosion, and destruction of ecosystems and weather variations with serious consequences on water bodies, fisheries, and livelihoods (Mensah and Koranteng, 1988).

In an effort to reduce post-harvest losses, the Leadership for Environment and Development (LEAD), a nongovernmental organisation (NGO), first introduced solar tent dryers in Malawi in the Lake Chilwa Basin, in Zomba district in 2007 in partnership with WorldFish - Malawi. Since then, there have been similar efforts in other parts of the country, along the lakeshore districts of Mangochi, Salima and Nkhotakota. The reduction of post-harvest losses is but one of the many benefits of using solar tent dryers, the other being that fish drying is faster and more hygienic than using traditional open sun drying methods. The resulting, improved quality of processed fish using the solar tent dryers enables fish processors to make better profits, which in turn improves their income.

The purpose of this study is to examine the usage of solar tent dryers for fish processing, their contribution towards building sustainable livelihoods. The analysis of the latter two contributions would serve to add to the body of knowledge on sustainable ways of implementing solar technology projects in fish processing. This is with attention to projects stressing the importance of community contributions and ownership of such projects. It is thus envisaged that the study will essentially contribute towards assessing community assets and social capital, crucial for sustainable community-based management and its prospects for project expansion when external funding phases out.

1.2 Background

This thesis is based on a 3-year research case study of a project titled ‘Sustainable Environment and Enterprise Development for Climate Change Adaptation in Fisheries (SEED-Fish)’. Funded by CABMACC, SEED-Fish was implemented in Linga Extension Planning Area (EPA) in Traditional Authority (TA) Malengachanzi, in Nkhotakota district in Malawi. The project was managed and coordinated by the Department of Fisheries and Aquatic Science at Mzuzu University (Mzuni) in partnership with Lilongwe University of Agriculture and Natural Resources (LUANAR, Bunda College), the Malawi Department of Fisheries at Monkey Bay in Mangochi district (FRU) and WorldFish – Malawi Centre in Zomba district.

The main aim of the project was “to improve livelihoods and food security through innovative responses and enhanced capacity for adaptation to climate change” (SEED Fish, 2016: 8). The

project began in July 2015; however, implementation began in February 2016 due to funds-related obstacles. Implementation of the project ended in June 2017. It was implemented with the main objective to improve incomes and livelihoods as well as environmental management of fisher folk communities to enhance their resilience to the effects of climate change. The project has three specific objectives:

i. To evaluate, test and adopt the use of clean energy and sustainable processing technologies on small fishes. The project intended to test and validate solar tent dryers and kilns, as climate smart fish processing technologies.
ii. To develop and test small-scale fisher folk entrepreneurial model. At the time of data collection, a Masters' student at Mzuzu University was developing the model that would enhance benefit of products (fish) and a toolkit for the same purpose.
iii. To develop tools or models for building capacity and governance. Thus, governance and capacity-building frameworks were, respectively, to be developed, tested and validated for small fish species and for improved income and environmental conservation.

The current research study presented in this thesis focuses on the first specific objective, under which solar tent dryers fall. However, progress on the other two specific objectives is also assessed as these objectives are linked to the implementation of the solar tent dryer component.

Two solar tent dryers were constructed in Chipala and Vinthenga Beach Village Committees (BVC) areas in 2015 and 2016 for the implementation of the SEED-Fish project. The reports, since installation of the dryers, show immense appreciation of the technology by the FPs such that there is need for more solar tent dryers as demand has overstretched supply (SEED-Fish, 2016). Following this development, the project intends to extend the holding capacity of the solar tent dryer at Vinthenga BVC to include more shelving for drying the fish.

1.3 Problem statement

With one fifth of Malawi comprising of lake bodies, fishing is a widespread trade around the surrounding, mainland areas. Fish are sold fresh or dried, but especially dried because only 10% of the Malawian population have access to electricity (Kambewa *et al.*, 2007) for storage. Dried fish is thus one of the most common and cheaply available fish on the market. Some of the processing methods require firewood to smoke or dry the fish and these have contributed to deforestation around fishing areas. The SEED-Fish project under CABMACC introduced improved fish processing solar tent dryers and improved smoking kilns to serve as a climate

change adaptation strategy by reducing deforestation that results from processing fish using firewood (LUANAR, 2013). However, it must be noted that innovative technologies, such as solar tent dryers, are expensive and require strategic consideration on how the communities can sustainably maintain and finance the introduced technologies.

1.4 Objectives and Research Questions

1.4.1 Main Objective and Research Question

The main objective of the study is to examine how the usage of solar tent dryers improves the livelihoods of fish processors in Chipala and Vinthenga. In this regard, the study addresses the question:

How does the usage of solar tent dryers contribute towards building sustainable livelihoods for FPs?

1.4.2 Specific Objectives

The research study has the following specific objectives:

a. **To analyse how solar tent dryers improve fish processing as compared to traditional methods**

This is meant to account for the improvements and challenges of solar tent drying, based on the information on sales and opinions of the respondent/participants, as well as the different drying methods by comparing the effectiveness of each method to solar tent drying. To measure the effectiveness of each method, the variables include the cost of the process, time spent processing and selling, and the retail price of a bucket of fish using the commonly used drying methods. Under this specific objective, the study addresses the question:
How have solar tent dryers improved the process of drying fish?

b. **To assess the sustainability of using solar tent dryers**

The study seeks to understand the measures put in place by the project as well as community initiatives to ensure sustainability of the solar tent dryers. Such measures are to account for the participation and levels of involvement in the project of concerned parties, which include the project officers, other stakeholders in the villages, local leadership, and the community at large. These would also point to the exit strategy of the project and progress made post the project timeframe (2015 – 2017) since the project phased out in June 2017. Under this specific objective, the study addresses the question:
What measures were put in place to ensure sustainable usage and adoption of solar tent dryers?

c. To examine adoption of the solar tent drying method

The study intends to document the number of FPs using only the solar tent drying method and those using alternative drying methods besides solar tent drying and the reasons for adopting and maintaining them. This also includes documentation of the challenges in adoption of the preferred technology.

Under this specific objective, the study addresses the following question:

How many FPs have adopted the solar tent drying method and, as result, how many have moved away from wood-fuelled processing methods?

d. To analyse gender perceptions in the fish processing communities

The study seeks to understand gender roles in the fish processing value chain as well as the society to which the FPs belong. The study examines how the documented gender roles affect the socio-economic status of FPs. Gender perceptions of men and women, as well as how these affect the success of innovative technologies such as the solar tent dryers are documented by answering the question:

How do gender roles and perceptions affect the socio-economic status of FPs?

CHAPTER 2: CONTEXTUAL BACKGROUND AND LITERATURE REVIEW

In this chapter, I present the literature review which has shaped and guided the research study. The aim of the literature review is to critically analyse the knowledge and interlinkages around fish processing, solar tent drying and livelihoods. In so doing, I have identified some of the limitations of existing knowledge as well as important aspects of it that I have used to discuss my findings in Chapter 5. Within the chapter I have also defined some theoretical perspectives that I argue as important to answer the research questions. The theoretical perspectives thus, compliment the conceptual framework used to analyse the data.

2.1 A Profile of Nkhotakota District

Nkhotakota district is in the central region of Malawi. The district is located on the south-west shores of Lake Malawi. Nkhotakota borders with Nkhata Bay district in the north, Mzimba district in the north-west, Salima district in the south, Kasungu district in the west and Ntchisi in the south-west (refer to Figure 4.1). The district also shares international borders with Mozambique in the east. Nkhotakota is 200 km away from the capital city of Malawi, Lilongwe. The human population is estimated at 303,659 with growth rate of 2.9% (SEP 2010). Traditional authority (TA) Malengachanzi, the area in which the research was framed, has an estimated population of 53,135, with a growth rate of 2.4%. Fisheries is a common source of income for many, however the population also engage in small-scale farming as well as other small businesses (Limuwa *et al* 2018). The Chewa are the predominant group in Nkhotakota, who follow a matrilineal lineage system. The commonly spoken language is Chichewa, which is also the national language in Malawi. However, in the northern part of the district ChiTonga is also spoken, which is the native language in the neighbouring district of Nkhata Bay.

The highest body in the local government structure is the district council. The council is the highest policy making body responsible for promoting infrastructural and economic development in the district (SEP 2010). The council is headed by a chairperson selected from the 10 publicly elected councillors. Members of parliament, senior chiefs and at least 5 TAs are members of the council. The District Executive Committee (DEC) are the technical advisory body to the district council and is comprised of the sector heads for all government line ministries working in the district, statutory corporations and NGOs.

The Traditional authority areas are represented by three committees (SEP 2010). The Area Development Committee (ADC) comprises of chairpersons, secretaries of VDCs, Ward councillors, religious leaders, youth representatives, women, business representatives and

chairpersons of the Area Executive Committees. The ADCs mobilise community resources and determine community development interventions. The Area Executive Committee comprises of government and NGO extension workers, who serve as the technical advisory body to the ADC. Village Development Committees (VDCs) facilitate all planning and implementation of development at community level. VDCs are crucial, as they are the closest bodies to the community members and oversee all other village committees. Thus, VDCs also have a representative from the Beach Village Committees which are responsible for fisheries and aquaculture activities at village level.

2.2 Fish drying in Malawi

Despite dwindling fish stocks in Lake Malawi, dried fish remains a primary source of protein for many people and contributes about 4 percent of the country's GDP (Mkoka, 2016). The common processing methods in Malawi are open sun drying (OSD), smoking and recently frying. OSD is the simplest and most inexpensive traditional method of processing fish, which involves drying fish on the beach, either directly on a drying rack or on a net on the sand. In this case, the fish is either parboiled, blanched or simply slated before it is left out to dry on the sand. The disadvantages of OSD are that it is seasonal, it requires a large area for drying, and takes longer time to dry the fish, leaving the fish exposed to contamination and insect attack (Yean *et al.*, 1998).

The smoking method, using a kiln, involves a combination of drying; deposition of naturally produced chemicals because of the thermal breakdown of wood and salting (Earle, 2013). Depending on the fish species, the processing time in the kiln is usually in three stages, a preliminary drying period at 30°C, during which the skin of the fish is first toughened to prevent subsequent breakage, followed by smoking and partial cooking period at 50°C and a final smoking period at 80°C (Bannerman, 2001).

The SEED-Fish baseline survey indicated that, recently, frying had become a trending processing method in Nkhotakota. Frying involves very high temperatures of between 160 and 170°C**,** which may degrade nutrients through hydrolysis and oxidation of the fatty acid**s**, increasing the quality of the products with better flavour and taste (Rossel, 2001). Cooking oil penetrates into the fillets during frying which increases fat content in fried fish (Saguy & Dana, 2003). However, studies have shown that the increase in fat content does not apply to all species. Candela *et al* (1998) found that different fish species perform differently during the process. This is especially the case in species that are naturally fatty (Kabahenda *et al*, 2009).

In Bagamoyo district, Tanzania, frying is reported to be the only processing method of fresh fish which is being practised (BD, 2009). In Ghana fish processing methods include 70.89% smoking, 11.99% salting, 7.01% drying and 10.11% frying (Britwum, 2009). In Kenya however, the frying of fish resulted in poor quality products because of contamination from the surrounding environment as well as prolonged hours of drying (Jumbe *et al*., 2008). Although no corresponding studies have been conducted in Malawi, the overuse of cooking oil in Nkhotakota has the potential to result in poor quality.

2.3 Solar tent drying methods

Solar tent drying in Malawi, as already mentioned, began in the Lake Chilwa Basin. The technology is simple and the construction materials are locally available, making it affordable for fishers to afford. The solar tent drying tents in Lake Chilwa have since been replicated in other districts of the country including Mangochi, Salima, and Nkhotakota.

Figure 2.1 Inside the solar tent dryer at Vinthenga. (Source: Fundi Kayamba-Phiri, 2017)

The structure is supported on a concrete base and the structure itself comprises of polythene sheets and a wooden frame. The tent traps warm air, causing the fish to dry faster as compared

to open sun drying, because the fish is dried in a controlled environment. There are other types of solar dryers such as tunnels and tents that use solar panels with better control of the amount of heat in the tent although these are more expensive technologies that the communities in Nkhotakota would not afford to replicate or maintain. A comparative study of sun drying and three types of solar tent drying, conducted in the Galapagos Islands, Ecuador (Trim and Curran, 1983), revealed that there was no significant difference in the drying rates of the solar tent dryers, however, fish dried 60-65% faster in the solar tent dryers than in sun drying.

Similarly, two tent stationary and mobile solar tent dryers introduced in a project in Sri Lanka showed that the tent dryers were also 60% more area efficient than the sun drying methods. The cost of the stationary and mobile tent dryers was not indicated; however the assumption is that the mobile tent would be more expensive as it would also require more time to pitch at a selected site. However, the benefits for each of them included ease of construction, which does not require skilled artisans, and makes the tent dryers faster and easier to adopt and replicate (Practical Action 2015).

The International Development Research Centre (IDRC) project in Zomba, Salima and Mangochi districts in Malawi is continuing to modify the design of the drying tent, to ensure that it delivers the right balance of ventilation and warmth (Mkoka, 2016). Solar dried fish was found to have significantly higher quality as compared to OSD: the low moisture content (7.22% vs 16.31%) and microbial load (more than three times better) are what lead to longer shelf life than in OSD fish (Chiwaula *et al* 2017).

The project linked FPs to transporters and distributers, and supply an established supermarket chain (IDRC, 2014). A recent study indicated that solar tent dried *Engraulicypris sardella* (Usipa) was selling at MK2300/5kg on the local markets, and MK 4500/kg in the supermarket, for the same quantity (Chiwaula *et al* 2017). The linkage would ensure sustainability after the project phases out owing to a stable chain of supply that would have been established between FPs and the supermarket chain. Prior to the IDRC project, a similar initiative was established in the Lake Chilwa basin project, where the fish were packaged and branded. However, the efforts of the communities to replicate such standards are questionable, a reflection of their economic status, as fish stocks continue to dwindle.

The solar tent dryers in Mangochi are either owned by a group or individuals. The solar tent dryers in the Lake Chilwa basin are under the management of a committee of FPs who are also

using the tent. Investigating possible contributions to group owned solar tent dryers, Chiwaula *et al* (2017) find that women were willing to pay MK 95,000 and men, MK 109,000.

2.4 Value chain analysis

Value chain analysis is an extension of traditional supply chain analysis (Gilbert, 2006), which is also a process that transforms raw products to saleable items for consumers by adding value to the product within each process (Will, 2008). The concept of value chain is introduced in the book 'The Competitive Advantage' (Porter, 1985). In the case of fisheries, different actors may be exposed to physical risks, climate-induced risks, health risks, currency devaluations and increased fuel prices, as well as political and security risks that may hinder the fishery activities (Adger *et al*., 2004).

In a value chain analysis, emphasis is placed on the interactions and relations between the different parties, firms and organisations influencing the market operation. The analysis illustrates how products are traded between different parties and what value each of those different parties add to the product. The analysis describes the process of creating value, which looks beyond production and includes the value addition activities that contribute to income (SEEP Network, 2006).

A value chain analysis describes the full range of value-adding activities required to bring a product or service through the different phases of production, including procurement of raw materials and other inputs, assembly, physical transformation, acquisition of required services such as transport and/or cooling, and ultimately response to consumer demand (Chiwaula *et al*., 2012; Kaplinsky & Morris, 2002; Weber & Labaste, 2009). Figure 2.2 below represents a typical fish value chain, which simplifies different processes that are involved in fisheries. For instance, the processes and distribution of varied species differ.

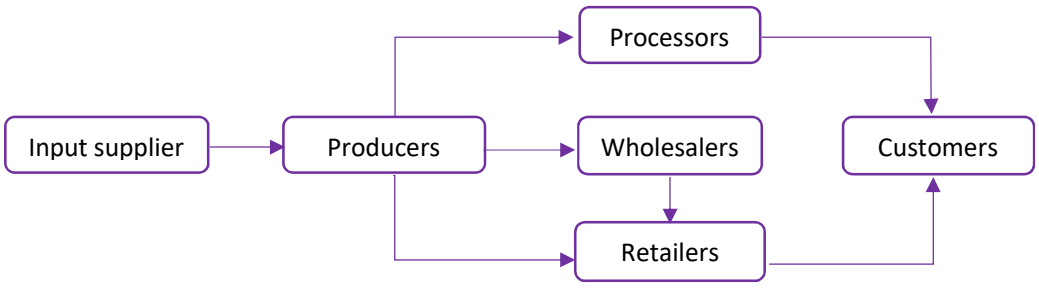

Figure 2.2: Typical fish value chain, adapted from the Chiwaula *et al* (2012)

Figure 2.3 represents a more elaborate distribution of different value-adding activities and can be used to describe distribution of specific species. I have adapted the value chain in Figure 2.3 to show how the most common species are processed in Chipala and Vinthenga, two of which are *Copadichromis virginalis* (Utaka) and *Engraulicypris sardella* (Usipa). To present a more elaborate representation I have included the distribution of the different methods used.

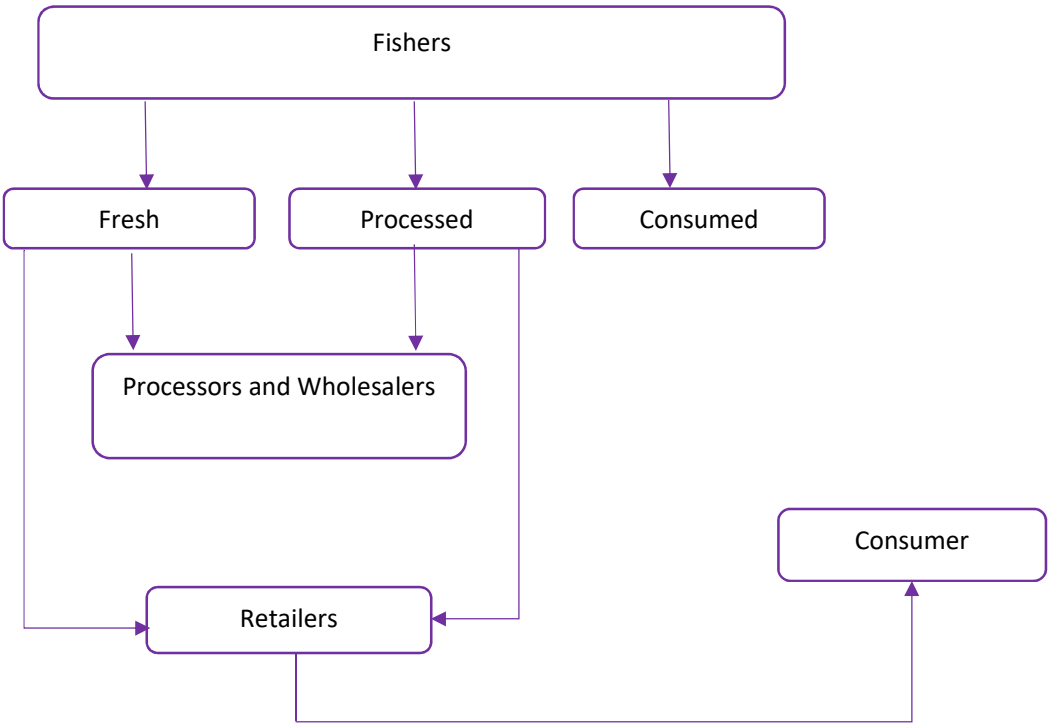

Figure 2.3: A typical distribution value chain adapted from the Chiwaula *et al* (2012)

I have used the fish value chain analysis as a tool to analyse the constraints and opportunities within the value chain, as well as the socio-economic role of different groups, such as women. The involvement of men and women in the fish value chain varies depending on economics, politics as well as culture (Chiwaula *et al* (2012). In fishing communities, men and women shape their lives around different fishing activities, which later on become part of their identity (Thompson, 1983). Fishing (actual catching of fish) is reserved for males and women are involved in pre and post-harvest activities in the fish value chain (McGoodwin, 1990).

Women play a vital role in the fishing occupation, paid or unpaid, and contribute significantly to their families and communities (Zhao *et al*., 2013). At the same time, women also contribute significantly to culture maintenance within their communities (Bisway, 2015). The women also contribute financially to the family needs within their households. A study in Comoros revealed

that the income of women from fishing was used for supplementary food, which helped to alleviate stress for the family (Hauzer *et al*., 2013, Zhao *et al*., 2013).

In most societies where women play a significant role in fisheries, the ability to fish is often synonymous with manhood and men who do not fish are likened to women (Matthews, 1993). Matthews (1993) states that in the Pacific Islands, deep-sea fishing of pelagic fish such as shark and tuna tends to be the men's domain. Women together with children only collect shellfish and other organisms in shallow waters close to the island (Matthews, 1993).

A study conducted in Nkhata Bay, a neighbouring district to Nkhotakota in the north, reveals that women also fish, but only for home consumption (Nakayama, 2008). Field observations revealed that although women engage in fish processing and trading, if the catch is large these activities are not restricted to women. In such cases, male FPs outcompete their female counterparts in terms of capital and mobility.

The restriction of women to pre and post-harvest fishing activities has various reasons across many cultures. Hanson (1982) states that the masculine association of fishing as an occupation restricts women from participating in catching fish. In other parts of the world, certain myths are placed on the involvement of women in fishing. For instance, in Samoa a woman's contact with any fishing equipment is regarded as bad omen (Bisway, 2015).

2.5 Deforestation, climate change and fish processing

Forest ecosystems in Malawi provide resources and services that are critical to the health and livelihoods of communities as well as the country's economy (USAID, 2015). Forests that have been affected by decades of deforestation are exploited for economic purposes such as agriculture, particularly for tobacco production, fire wood and charcoal production (USAID, 2015). The reduction of forests in Malawi also reduces the safety net of forests as a last resort for the survival of many rural inhabitants (USAID, 2015). Poor farmers in southern Malawi, much as elsewhere in the country, use forests to cope with climate variability as a source of food and cash during food shortages and crop failures (USAID, 2015). In Malawi, firewood is also used for processing fish, through the smoking and deep-frying methods.

Improved fish smoking kilns were introduced in Malawi by the Lake Chilwa Basin climate change project. Studies by Luhanga (2012) observes that the average wood usage per kg of fish

was higher in traditional smoking than in improved efficient (fuel energy saving) fish smoking kilns. The improved fish smoking kilns used an estimated 30% less wood to smoke a given unit of fish than the traditional fish smoking methods. Furthermore, Mustapha *et al*. (2014) argue that improved fish smoking kilns use over 50% less firewood than the traditional smoking methods. The availability of improved smoking kilns as well as solar tent dryers entails that fish can be processed at a lower cost, which benefits the FPs by making better profits, producing healthier products, as well as reducing the effects of fishing on the environment.

The impact of climate variability and change has been observed to affect catch composition in Malawi (SEED-Fish, 2015). Over time, for example, while the production of small species such as Usipa – *Engraulicypris sardella*, Kambuzi - *Nyassachromis spp.* and Utaka - *Copadichromis spp.* has doubled from 56,463 tons in 2004 to 98, 299 tons in 2010, the production of bigger species has continued to dwindle (FAO, 2016). In a related development, the baseline survey conducted in Linga EPA for the SEED-Fish project, 5.4% of the respondents (n, 100) indicated that fish populations had remained constant, and only 1.5% of the respondents indicated that there had been an increase in fish populations (SEED-Fish, 2015). Regarding the current levels of fish populations, 36% of the respondents explained that the low levels were due to overfishing, while about 27% indicated climate change as the main cause (SEED-Fish, 2015). Use of illegal fishing gear, other illegal fishing methods such as the use of poison and lack of civic education were, respectively, indicated by 10.3%, 0.5% and 1% of the respondents to have been the cause of the decrease in fish populations. Thus, the data provided by this study, based on fishers' perceptions, appear to suggest that even though fish stocks are affected by climate change, there are other contributing factors to the same.

2.6 Sustainable livelihoods

A livelihood comprises capabilities, tangible and intangible assets, and activities required as a means of living. According to Ellis (1999), these components of a livelihood jointly determine the living gained by individuals or households. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base (DFID, 1999). Further, sustainability here is defined as a requirement that the use of resources today does not reduce real incomes in the future. To this end, little research has been done on livelihood sustainability amongst FPs in Nkhotakota (Allison and Mvula 2002). The study therefore tries

to understand how the introduction of new processing methods affects the livelihoods of FPs; that is, both tangible and intangible assets and resources.

2.7 Diversification

According to Allison and Mvula (2002) fisherfolk have responded dynamically to reduced opportunities in fishing and increased opportunities elsewhere. Diversification of income sources has been an effective survival strategy for vulnerable groups with limited access to assets (Ellis, 1998). Diversification is here defined as a process by which a household increases the number of its income generating activities (Ellis, 2000).

One of the challenges of diversification in most rural parts of Malawi is the lack of access to micro credit loans. The lack of micro credit loans makes it hard to increase their income generating activities. Of those involved in the fish value chain, FPs who also market and sell fish are the least expected to diversify their income generating activities. A study conducted by IMM (2003) in Bay Bengal revealed that given diversification opportunities, FPs and marketers benefited the least due to the fact that they lacked other financial and physical assets, such as land, to allow for entrance and investment in other income generating activities.

2.8 Governance

In a traditional sense, governance has been related to the government and its activities. However, interactive governance theory and other approaches to governance in fisheries argue that governance includes other actors besides government (Jentoft & Chuenpagdee, 2009). In Iceland, an individual transfer quota system (ITQ) was introduced to achieve ecological stewardship, economic efficiency and safety at sea (Sampson, 2013). The system is a neoliberal solution to the control of fisheries resources. Furthermore, Palsson (2006) finds that ITQs, a high modern regime, benefits mostly capital and boat owners and scientific experts; whilst marginalising the small fishers, crews and local knowledge. The emphasis on recovering fish stocks across the globe has seen economic and ecological components at the centre of policy and governance, while the socio-cultural domain is either completely ignored or not prioritised (Urquhart & Acott, 2013; Reed *et al*., 2013). Often modernist governance fails to consider nature and society together (Palsson, 2006) by undermining the local place and its importance, which are both complex and diverse (Sampson, 2013, Jentoft and Chuenpagdee, 2009).

For Johnson (2006), governance is a process that should reinforce the ties among different stakeholders and foster dialogue, debate and collaboration among stakeholders through interaction. McGoodwin (1990) criticises the capitalist way of governing resources by

underpinning the exclusion of social and cultural considerations. However, the interactive governance theory merges an existing governing system and the system to be governed to a common platform where they interact to manage fisheries (Johnson, 2010; Jentoft, 2007) while paying attention to all the societal and cultural values of place (Jentoft & Chuenpagdee, 2009).

2.9 Co-management of natural resources in Malawi

The different sets of rules, processes and behaviours that a country adopts may influence the way in which powers are exercised (Gray & Hatchard, 2003). Industrialised fisheries adopted in developing countries, have centred on the introduction of various instruments granting private rights to fish. In least developed countries, the community, rather than the individual or firm is widely seen as the unit in which to invest access rights to fish resources. Thus, similar to other renewable natural resource sectors, fisheries policies have emphasised the introduction of community-based natural resource management (CBNRM). CBNRM, referred to by a variety of, often interchangeable, terms such as participatory, collaborative, joint or co-management, is defined as:

> "Ideas, policies, practices and behaviours that seek to give those who live in rural environments greater involvement in managing the natural resources that exist in the areas in which they reside (be that permanently or temporarily) and/or greater access to benefits derived from those resources" (Hulme and Murphree, 2000).

The government of Malawi adopted the CBNRM initiative under a co-management arrangement, guided by the co-management of natural resources policy, which is currently operational. Co-management is aimed at increasing user communities' partnerships in managing resources that they depend on for livelihoods to yield better management outcomes (Ngochera *et al.*, 2017). This is appropriately aligned to the decentralisation policy and legislation (GoM 1998a, 1998b), based on principles of bottom-up planning, which means that communities decide and prioritise issues and aspects of development directly impacting their livelihoods in their local areas. Co-management was also adopted because government lacked the capacity to manage natural resources across the country. The benefits of CBNRMs are non-financial: "the empowerment of people in rural areas, conservation of biodiversity, and the development of more secure livelihoods and the reduction of risk." (Fabricius, 2004:3)

Alike other natural resource-based sectors, the implementation of co-management regimes in the fisheries sector was assumed to benefit the resources and their users (Ngochera *et al.*, 2017). However, recent empirical studies (Weyl, 2008; Béné *et al.*, 2009; Njaya, Donda, and Béné,

2011; Hara, Donda, and Njaya, 2002) highlight the potential problems that may arise from such natural resource governance reforms due to lack of capacity and resources. These studies analysed co-management arrangements of fisheries in Malawi as having problems that arise particularly around power distribution, how to determine the responsibilities of the various role players in co-management arrangements, such as Beach Village Committees (BVCs). The prevalence of such problems is quite understandable considering that BVCs consist of different community members, who represent their communities on various fisheries and related activities.

Furthermore, despite the enactment of policies and legislation on devolution of authority and decentralisation, the norms of centralised management remain deep-rooted in most officials in Government Departments (Chinsinga, 2005). One suggestion to overcome this problem is that policy makers should adopt integrated management planning that addresses the diverse interests in the natural resources, the ecological, socio-economic and external factors that threaten sustainability of ecosystems and livelihoods of dependent communities (Jamu *et al*., 2011). Left unresolved, such diverse and competing interests create conflict since problems usually cut across spatial and temporal scales, or are linked to diverse cultural and legal systems, within a tradition of non-cooperative behaviour (Jamu *et al*., 2011). This form of fragmentation in commons management occurs at different levels: technical expertise may be split among government management agencies and NGOs; or resource management activities may occur across different socio-geographical scales, i.e., local, national and international. For instance, those in fisheries interact and work with others in fisheries, and likewise those in forestry work in a similar manner.

Despite availability of action plans, management of resources in Malawi continues to be fragmented, characterised by "lack of coordination in planning and management and a disjuncture among and within policies and the various pieces of legislation" (Ngochera *et al*., 2017: 3). In their study, Ngochera *et al*. (2017) reveal that in the southeast arm of Lake Malawi, respondents indicated fishing, tourism, forestry, and agriculture activities interact with fisheries, which underscores the need for coordinated planning and management and key to implementation of co-management regimes.

Equally important are the relational interactions between levels of resource management in decision-making and in carrying out co-management prescriptions. Cleaver (2002) coins the term "bricolage" which she defines as "how mechanisms for resource management and collective action are borrowed or constructed from existing institutions, styles of thinking and

sanctioned social relationships". Thus, caution must be exercised to ensure that institutional vestiges relating to centralised management regimes do not conspire to frustrate mechanisms promoting participatory, co-management approaches. For instance, while the government has moved away from a top-bottom to bottom-up approach to natural resource management, there may be still some traits of top-bottom interactions between local organisations and resource users. At the same time, similar traits can still be traced within government sectors in their approach to co-management, where decisions are not entirely bottom-up. For instance, in Chimaliro Forest Area in the northern region of Malawi, the formation of Village Natural Resource Management Committees (VNRMCs) was done by the community during community meetings however "under the auspices of and with the advisory services provided by the forestry department" (Kayambazinthu, 2000).

A related institutional challenge confronting co-management of natural resources appears to be associated with competing and often overlapping leadership roles, to guide and spearhead the process, at the local community level. At this level, the roles of chiefs in co-management arrangements is unclear (Kamoto, 2014; Hara *et al*., 2014), which is evident from the competition for power that arises between local chiefs and local organisations, as vehicles for user participation in co-management of natural resources through Beach Village Committees (BVCs) and VNRMCs. There is clearly need for these roles to be clearly defined at the outset to avoid confusing the co-management process and community participation.

In management of natural resources, one challenge that remains critical to sustainable resource management is obtaining accurate valuation of the natural resources being managed (Ngochera *et al*, 2017). Such valuation can serve to provide essential information on the value of resources before or during management interventions, vital for determining progress, success and effectiveness of co-management to the natural resources and livelihoods. Whilst the importance of fisheries to the economy, livelihoods, ecology, and culture in fishing communities in Malawi is widely recognised, the specific challenge is that the understanding of its actual value remains sketchy, especially in communities where fishing is the main mode and source of meaningful livelihoods (Hara and Njaya, 2016).

2.10 Conclusion

In this chapter of literature review, the intellectual rationale for the study has been outlined by briefly presenting fisheries in Malawi and where fish processing is placed in the fish value chain. The chapter also dealt with fish processing and the importance of value chain analysis. Literature on the solar tent drying method has been included in order to understand the knowledge generated so far on the method. Within the value chain, literature on gendered roles has also been outlined.

A brief discussion of literature on fish processing and deforestation included some of the popular fish processing methods, which are woodfuel based. Lastly, literature concerning sustainable livelihoods, included the diversification of income sources as well as governance and management of natural resources. Natural resource governance structures have been observed as responsible for development initiatives within natural resource sectors. Thus, this study benefits from understanding the governance roles that different BVCs play in advancing technologies such as solar tent dryers that reduce post-harvest losses of fish, which is a critical natural resource in Nkhotakota.

CHAPTER 3: THE SUSTAINABLE LIVELIHOODS APPROACH

In this chapter the theoretical and conceptual frameworks are presented. As frameworks are based on theory, the theory behind the sustainable livelihood approach (SLA) is briefly discussed, following a discussion of the sustainable livelihood framework and how it has been applied to respond to the research question of this study. The SLA eventually forms the basis for analysing the findings in the study.

3.1 Sustainable development

The Brundtland Commission (UN, 1987) drew the definition of sustainable development from the report of the World Conservation Strategy (WCS) of 1980 (Blunden, 2014). The commission intended to redefine the terms of reference (TORs) used in the WCS, as the UN General Assembly found the terms of reference conservatively biological in nature. The redefined TORs incorporated the social, economic and ecological considerations related to development (Blunden, 2014).

Sustainable development is defined as the "ability of present generations to meet their needs without compromising the ability of future generations to meet their own needs" (Brundtland Commission, 1987). Similar to the definition of 'development', sustainable development has been debated and thus defined differently within different disciplines (Lafferty, 2004; Robinson, 2004; Williams and Millington, 2004; van Zeijl-Rozema *et al*., 2007). The nature of sustainable development is thus explained as normative, subjective, complex and ambiguous (De Kraker *et al*., 2005). However, the different perspectives of what sustainable development is, informs the implementation strategies of projects that concern livelihoods, especially those of the poor.

3.2 Intentional Development

The SLA is founded upon the notion that intervention must be based upon an understanding of what underpins livelihoods and on what is known as intentional development (Morse and McNamara, 2013). Cowen and Shenton (1998) categorise development into two basic forms: immanent and intentional development. Immanent development denotes a broad process of advancement of human societies that is driven by factors that include advances in science, medicine, the arts, communication, etc. Immanent development is thus a long-term and continuous process for governments with investments in infrastructure, health and education. However, immanent and intentional development take place simultaneously, with the former providing the basis for areas where intentional development is needed.

Intentional (or interventionist) development is a focussed and directed process in which government and its development partners, namely NGOs, implement projects and programs with the intention of helping the poor (Morse and McNamara 2013). These projects and programs are usually time and resource based, with the intention that the effects of an intervention continue after a project has phased out.

Critics of Intentional Development

Morse and McNamara (2013) argue that intentional development has not been successful. There are several reasons for this argument. First, intentional development is based on a construct of what is and what is not developed, and thus also what development means. Second, due to the construct of what is developed, a top-down approach to development is applied, with rich countries setting the agenda of what development should be and also how it should be implemented. This is in turn viewed as almost a reconfiguration of colonialism, which has also made beneficiaries of interventions dependent on aid and thereby creating a lack of agency to become self-sufficient (Moyo, 2010). Thus, at international or local level, "the net result of aid dependency is that instead of having a functioning Africa, managed by Africans, for Africans, what is left is one where outsiders attempt to map its destiny and call the shots" (Moyo, 2010: 66). Thus, as indicated in the problem statement, examining how technologies that are meant to improve livelihoods of the poor is necessary to determine whether the intervention process is one that will result in sustainable livelihoods.

3.3 Contextualising Sustainable Livelihoods Framework

The research study examines the sustainability of using solar tent dryers to improve the livelihoods of FPs, particularly as fish is crucial to the income and dietary needs of people and especially fishing communities such as those in Nkhotakota. The decrease in fish populations affects fisher folk whose income is dependent on their fish sales. Furthermore, fishing in Malawi is affected by climate variability and change, which makes fishers' livelihoods vulnerable, as they struggle to be financially stable to sustain their families.

The Department for International Development in the UK (DfID, 1999) developed the Sustainable Livelihoods Framework (SLF). The framework is unique because it is centred on people, particularly the poor. However, the SLF has been criticised for not providing guidelines of how to identify who the poor are (Morse and McNamara 2013).

Poverty has been defined as multidimensional, because of the inability of one dimension alone, income for instance, to reflect the living situation of an individual. Other measures such as

access to basic needs such as education and health facilities as well as assets such as housing and livestock, are included to determine if one is poor or not (Alkire *et al* 2015). Measuring multidimensional poverty is defined by the context of the sample in question. The SLF identifies the main factors that affect people's livelihoods and the inter-relationships thereof. Within this framework the process of defining poverty in Chipala and Vinthenga was done based on how the participants defined different persons in the community.

The poor need to survive every day as well as accumulate assets to become resilient to the shocks and long-term stresses. The framework model is therefore divided into people, basic needs, resources, assets, shocks and trends and access and control. The arrows within the framework do not necessarily entail causality, but rather the direction of influence (Figure 3.1). The framework can be used for planning development activities or assessing the sustainability contribution of existing development activities towards livelihoods.

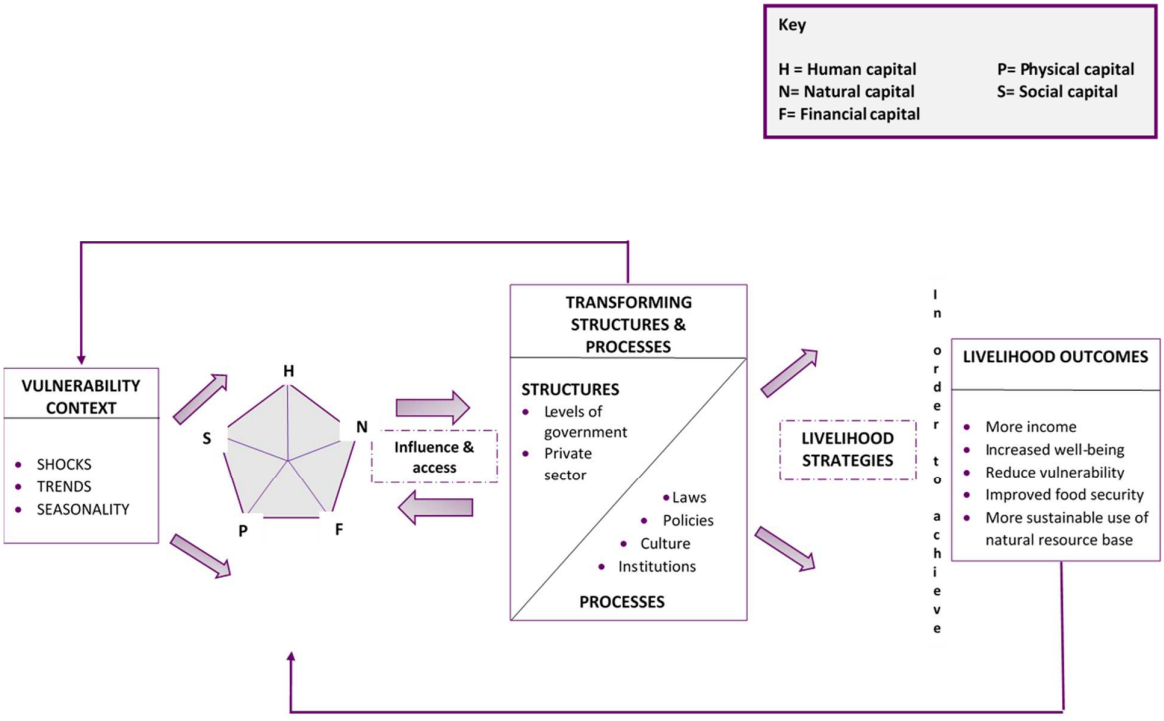

Figure 3.1: Sustainable Livelihoods Framework by DfID (Source: DfID, 1999)

The first part of the model depicts the vulnerability context which is concerned with the shocks, trends and seasonality that affect people's livelihoods. The decrease of fish population due to overfishing is linked to the increase in human population. The study considers the extent to which human population growth is contributing towards the decrease in fish population by assessing the FPs' market and demand for fish. The study also assesses whether the solar tent

dryers have contributed towards satisfying the demand for processed fish. The attitudes of migrant FPs are also assessed to establish whether there are different views of adopting the new technologies amongst themselves.

The vulnerability context is not always negative and may include the introduction of innovative technologies, giving an opportunity to assess whether the technologies are being utilised by the targeted group and their impact on the socio-economic status of the FPs. The study considers the resource trends, which in Nkhotakota include illegal fishing taking place outside the fishing season.

The study also assesses the FPs' sources of income, to determine what other shocks may affect their flow of income. For instance, if climate variability results in fish catch decline, could other occupations sustain the livelihood of FPs? The vulnerability context thus draws attention to the complexity of the factors that contribute directly or indirectly towards the overall vulnerability of the poor. Given this complexity, the poor may not always be able to change or manipulate their situation, either because of lack of assets or existing structures and procedures to adapt to their situation.

The SLF model divides livelihood assets into five groups; human, natural, financial, physical and social capital. Human capital in the study includes the skills and knowledge used for the sustainable use of the technologies within the community. Within the framework, there is a close link between the human capital and the vulnerability context, particularly shocks. This is because some of the shocks are as a result of the natural resource management in a community. The Malawian currency inflation, and thus purchasing power poses as an economic shock because the price of fish equally increases as life becomes more expensive. Fish has thus become more expensive in the local markets, prices that most of the population cannot afford as before, which affects the fish sales of FPs. The perceptions and behaviours towards the natural resources such as forests, water as well as land are assessed in the study. Under financial capital, the income levels of the FPs are assessed. Access to micro financing institutions or other alternatives such as village banks gives insight into how the technologies have improved their income, as well as how much the FPs can contribute towards maintaining and replicating the technologies to increase access to clean energy processing.

The physical capital assessed are the type of housing that the FPs have, the fish processing equipment that they own for their trade, transportation, as well as access to information. Linga EPA is accessible by road, and is closest to the *Boma*, which entails better access to markets

than other communities along the lakeshore do. The social capital looks at the family dynamics of the FPs and how these affect their trade. This is also linked to the cultures present in Nkhotakota which have gender roles. Access and control of resources, especially income were crucial, also because most FPs are women of which some may not have control over their income. Involvement in different community groups is also assessed and how it contributes to the wellbeing of the FPs.

The transformational structures and procedures, depicted in Figure 3.1, relate to the levels of governance, the role of the private sector, the laws, policies, culture and institutions within the community. In this regard, the local governance structure is assessed in terms of how they serve the local communities, how information and decisions flow and are made between the local, district and national levels. Thus, the assessment includes the laws and policies governing the trade of fish in Malawi and how the local communities inform policy processes.

Governance is also assessed in terms of how the laws and policies are followed through in the district. The same is assessed for the private sector, of which SEED-Fish is part of. The project is assessed in terms of how it has worked with both the local government as well as the communities themselves. Only men catch fish out in the lake, and women are involved in inland processes only, including owning gear, processing and marketing of the products. The culture of the community is also assessed in terms of how the fish value chain is organised, by assessing the perceptions of the fisher folk towards the roles that men and women have.

3.4 Conclusion

In this chapter, I have defined sustainable development, and discussed intentional development, which is the theory behind the SLA that has been used to analyse and interpret the data in this study. The different but interlinked processes within the SLF exemplify the importance of contextual as well as interdisciplinary approaches to development, that aim at improving resource management, however, with the improvement of livelihoods at the centre of the agenda.

CHAPTER 4: METHODS

This chapter outlines both the qualitative and quantitative research methods used in the study to answer the research questions in Chapter 1 (Section 1.4.2). The research findings were triangulated using data obtained from interviews and observations, as well as from survey results. Thematic analysis was used to analyse the qualitative data, while several statistical analyses were used to analyse the quantitative data. The mixed methods design has thus been used to enrich and explain the findings of the study by capitalising on the strengths of both qualitative and quantitative research.

4.1 Research Design

To examine the use of solar tent dryers and how they impact the livelihoods of FPs and the environment, this case study adopts an in-depth and systematic approach; from data collection to analysis and in reporting the results (Flyvbjerg, 2011: 301). This approach involves a contextual and in-depth examination of a subject of study and enables the researcher to have a sharpened understanding of the case being studied, which includes how and why events have taken place, as well as identifying what might be important for future research in a given context (Flyvbjerg, 2011: 301).

4.2 Mixed Methods

The research study uses a mixed method of research, by collecting and analysing qualitative and quantitative data in a single study (Creswell, 2012). Combining both methods reduces biases that might occur in either of the two methods because the weaknesses of each method are counterbalanced by the strengths of the other method (Bryman, 2012). Since the study uses the sustainable livelihood framework (SLF), qualitative findings gave a wider and in-depth view of the different processes and outcomes of fish processing and how using the solar tent dryers impacts the livelihoods of FPs. The qualitative findings then provided a frame to develop a more focussed survey questionnaire to collect the quantitative data. Quantitative methods have however been discussed as more informative, based on the sampling technique that allow a researcher to remove bias as well as generalise findings (Bryman, 2012), although they are limited in explaining the underlying factors and processes, for example those that may contribute to poverty (Howe and McKay, 2005).

It is thus common to use quantitative information to conduct large-scale statistical analysis for impact assessments, especially when measuring how an input leads to certain development

outcomes. At the same time, other assessments depend on qualitative data to be used to understand better the causal chain that may not otherwise be explained by statistical correlation (Farouque, 2007). The mixed methods design assists to confirm or refute the qualitative and quantitative data through a triangulation process.

Sequential exploratory design

The study uses the sequential exploratory design, which entails that qualitative data was collected prior to quantitative data (Creswell, 2012). The design helped to develop the survey questionnaire that was responded to by FPs. Refer to the Appendices (1 to 5) for the interview guides.

Strengths and weaknesses of the research design

Whilst a researcher gains more from collecting data in phases, that can be a limitation especially when time and resources are limited. This study benefited from the sequential exploratory design because whilst the data collection tools were being prepared, there were no reports or feedback that the dryer in Chipala was not in use. The discovery was made during the first focus group discussion with the 'solar-drying method fish processor group', which turned out to be BVC members due to the absence of any FPs using the dryer. To start with, the questionnaire used to collect both qualitative and quantitative data simultaneously would have prolonged the data collection process, with more probing questions to respondents. However, semi-analysing the qualitative data to refine both the questionnaire and semi-structured interview guide took over a week, which affected the amount of time left to administer the survey questionnaire. However, the quality of the data collected was not compromised as research assistants were employed to complete data collection in time. This of course required more resources, namely funds and devices used to collect data.

4.2.1 Implementing the research design

A combination of qualitative and quantitative data collection tools was used in the research study. These are focus group discussions, observations, quantitative survey and secondary data sources. The research design is illustrated as follows (Figure 4.1):

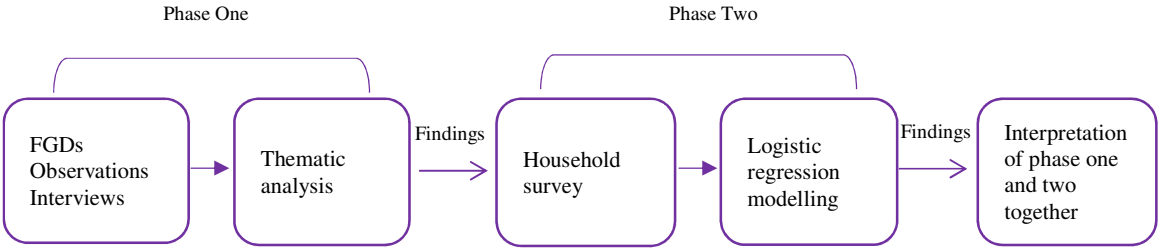

Figure 4.1: Implementation of research design

4.2.2 Choice of study area

Chipala and Vinthenga villages were selected as the study areas because solar tent dryers had been installed in only these two areas under the SEED-Fish project. The two villages are not far from the trading centre (*boma)* making them easily accessible for data collection while lodging at the *boma.* Figure 4.2 shows a map of Malawi and the study area in TA Malengachanzi.

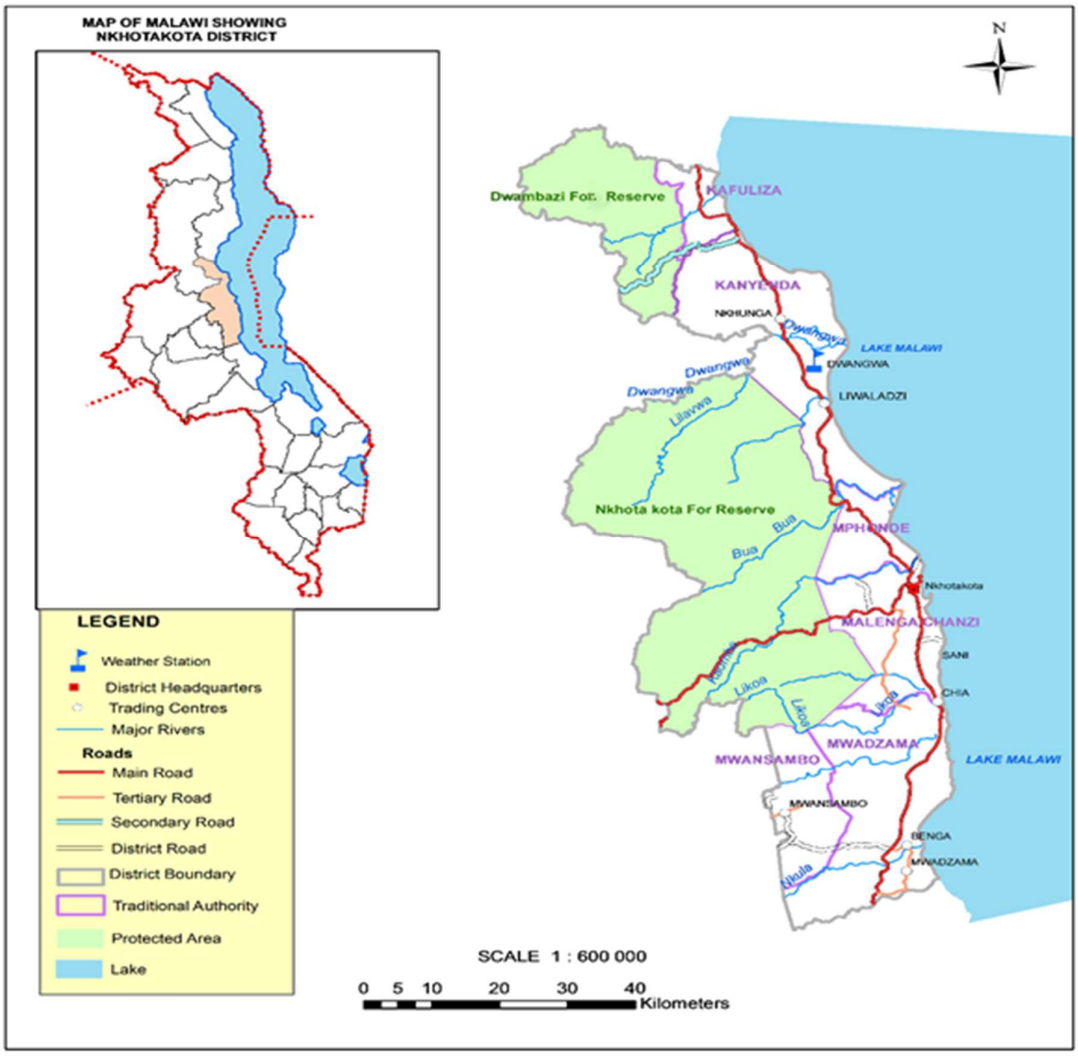

Figure 4.2: Map of Malawi showing Nkhotakota district and the study area (Source: Limuwa *et al* 2018)

4.2.3 Key characteristics of participants

Prior involvement in the SEED-Fish project was a key characteristic, which implies that all FPs and other stakeholders were eligible to be targeted in the research study. Both male and female FPs were therefore selected to understand the gender perspectives influencing the introduction of solar tent dryers. The inclusion of both old and young FPs in the study was another key characteristic designed to benefit from experiences from either group, to understand different perspectives based on years of expertise in fish processing.

4.3 Sampling procedure

Data collected from traditional leaders provide insight into how the local authorities perceive technological innovations in relation to development in their communities. Further insight is gained through the participation of officials to determine the extent to which authorities are involved in the project, given their influential positions in the communities. To this extent, the SEED-Fish project staff in Nkhotakota, Fisheries and Forestry district officers, were interviewed to present their office's perspective.

The study focused on the household as the unit of analysis, with the sampling criterion being involvement in fish processing, whether directly or indirectly by, for instance, leaders and committee members involved in the SEED-Fish project in Chipala and Vinthenga Beach Village Committees (BVCs). The criteria did not include selection of household heads but rather members of a household that are involved in fish processing.

The rationale for avoiding inclusion and therefore classification of household heads, be they either female or male, is because the labels 'female-headed' or 'male-headed' households are problematic. This is essentially because the former label appears to name a category of households with a common factor, that is, the absence of a man. Yet, "the experiences, resources and cultural contexts of these households imply diverse predicaments", and the lack of a male may not be a determining characteristic (Connelly *et al*, 2000: 80). Another criterion relates to the age of the members of the household, with the minimum age being 18, when persons are no longer minors and can be involved in fish processing, and therefore could contribute to the discussions.

4.3.1 Implementing phase one

Qualitative data was collected through focus group discussions (FGDs), observations and individual interviews.

Focus group discussions

Two focus group discussions each were conducted in Chipala and Vinthenga villages. In each village, both groups included members of the BVCs and FPs, to provide a better understanding to the research questions of the study. I intended to separate men and women for the FGDs, as culturally in Malawi combined groups hinder women from expressing themselves, as men are given the priority to talk and debate issues. However, since most of the participants were women, the groups were only categorised as adopters and nonadopters.

The FGDs provided insight into the different perspectives that people may have on issues, how they coordinate in resolving differences and reach a consensus. Such observations were beneficial particularly in FGDs with both men and women, where issues to deal with gender and changing gender roles were expressed. The women were able to express themselves freely, and their sentiments were echoed by the men. This also allowed for observations to be made on how gender is discussed and negotiated within these communities. For detailed capture, the discussions were recorded using a smartphone voice recorder as well as notetaking.

One of the weaknesses of FGDs is that the researcher has less control over the flow of the discussion, as compared to individual interviews (Bryman, 2012). For this reason, the number of group participants was limited to 8 participants. Additionally, FGDs often fail to provide information on frequency and distribution of beliefs within a community (Creswell, 2012). To overcome such difficulties, the quantitative survey questionnaire was used, which was also informed by the central themes identified through the FGDs. One pilot FGD was conducted in the Lake Chilwa Basin to determine any necessary changes or clarifications. The Lake Chilwa site was selected because it is the oldest but still having a functioning community solar tent dryer. The site was also identified because of its proximity to where I was staying in Zomba city.

Observations

The research study involved participation observation. This is an observation process that involves the researcher participating in the activities intended to be observed (Creswell, 2014), with the researcher's identity either known or concealed. For purposes of this research study, the researcher's identity was known, as other data collection tools were used in the same communities which required the researcher's information and intentions. Despite this fact, it was still possible not to reveal the purpose of the observation, to ensure that the activities took place in the most natural way possible. The observations have been used to triangulate and strengthen the data collected through interviews and the survey questionnaire.

Sampling strategy of the qualitative data

Participants were identified with the assistance of the project staff who had worked with the committees and FPs as well as other stakeholders. The project staff liaised with the committee members in each village, who then mobilised the participants. This method, known as purposive sampling, assisted to identify participants with the necessary experience relevant in

responding to the research questions (Bryman, 2012). Through a screening process, I confirmed that all the participants were FPs, and that in Vinthenga, they were using the solar tent dryer.

Phase one data analysis

Qualitative transcripts were analysed using thematic analysis, which identifies implicit and explicit ideas within data by counting and analysing the phrases and words used by participants (Guest *et al*,. 2012: 10). To achieve this, a process of coding was done, which is the primary process in identifying themes within raw data by recognising important moments in the data prior to interpretation of the data (Boyatzis, 1998: 1). The qualitative data were processed and partly analysed in the field to determine whether the questions in the survey questionnaire needed to be changed or complimented by other questions and/or options. This involved listening to the audio recordings during the FGDs and referring to the notes taken, to determine some of the recurring themes found in the data. The audio files were later transcribed to conduct a more extensive coding process to determine the themes.

Follow up interviews

After conducting the FGDs and interviews, I discovered the need for follow up interviews in Chipala. The main reason for this was to understand the depth of the problem in Chipala; why FPs were not using the dryer. The reasons given during the FGDs and interviews with traditional leaders, and officers contradicted each other and did not provide the basis of the problem especially at community level. For this reason, I set out to find and interview the only lady who had used the dryer in Chipala. Following the interview, I had to interview a BVC member who the fish processor had worked closely with whilst using or attempting to use the dryer.

4.3.2 Implementing phase two

A hundred household survey questionnaires were administered to FPs. The initial plan was to administer all the 100 survey questionnaires myself, however due to time constraints I had to engage 3 research assistants. The questionnaires were administered over the space of a week. On average 18 questionnaires were administered per day, with about 25 minutes per questionnaire. The questionnaires were electronically administered using tablets and phones.

A Google form was used to design the questionnaire and administered through Google Chrome with the local network internet. The electronic survey questionnaire saved time and paper, as the data was automatically uploaded and later downloaded as a complete dataset. However, during data collection, one of the questionnaires was uploaded twice, thus after cleaning the

data the sample was 99. The consent, and questions and corresponding response options were read out to the respondents by the researcher or research assistant who then recorded the responses. The pilot survey, involving one pilot FGD, was conducted with 8 respondents to determine any necessary changes or clarifications.

Minor changes were made to the questionnaire, even though following the first interaction with the SEED-Fish staff the questions had to be revised. For instance, the users of the dryer at the Lake Chilwa site had formed a group and thus it was more important to understand how the group dynamics worked. In Nkhotakota, the dryers are used by individuals, thus some of the questions needed to be omitted. For this reason, the first FGD at Chipala took longer than the rest, as there were still more adjustments to be made. The first FGD at Chipala lasted for 104 minutes, whilst the shortest FGD was 45 minutes long.

Sampling strategy of the household survey

A probability sampling method was used, using stratified random sampling. This method is used when it is necessary to have representation of subgroups within an identified population (Berg and Lune, 2012). These subgroups were the villages, fish processing methods and gender of the respondents to ensure an equal representation of the three subgroups in the sample. During data collection it was discovered that most FPs were female, and thus the data were skewed in this regard. The data were also skewed with regards to those using the dryer, as it was discovered that the dryer in Chipala is not in use.

Phase two data analysis

Statistical Package for Social Science (SPSS) and Microsoft Office Excel were used to analyse the quantitative data. Descriptive statistics were used to both check the variables, some of which were included in the logit regression model (Moses and Knutsen, 2007). Graphs were computed using the two statistical packages mentioned above. Inferential statistics were used to make inferences and predictions about the characteristics of the population from which the sample was drawn (Brase and Brase, 1987). Testing the data in this manner allowed for logit regression modelling to determine the factors that affect FPs' participation in solar-drying activities. To analyse the quantitative data, I used logit regression modelling, t-tests, Simpson's diversity index and an income analysis; comparing fish processing income against income from the FPs' other occupations.

After discovering that the dryer was not in use in Chipala, predicting the factors that would result in participation in solar-drying activities was necessary. I used logit regression modelling to test factors that may contribute to a fish processor's participation in solar tent drying. When the dependent variable in a study is dichotomous (i.e., participants in solar-drying activities vs non-participants), logit regression, as opposed to either multiple regression or discriminant analysis, is particularly appropriate (Hosmer & Lemeshow, 1989; SPSS, 1989). Logit regression analysis provides predicted probabilities of participation for combinations of the independent variables (Pyke and Sheridan, 1993).

Compared to multiple linear regression which uses the conventional Beta coefficient, interpretation of the logistic coefficient is more difficult because the logistic model is rewritten in terms of the odds of an event occurring, defined as the ratio of the probability that an event will occur to the probability that it will not (Pyke and Sheridan, 1993). In this case, factors with values greater than one, indicate that the odds are increased; and those with values less than one indicate that the odds are decreased (SPSS, 1989).

The following procedure was adapted from Hosmer and Lemeshow (1989) and utilised in the study to select significant independent variables and interactions. The first step involved a stepwise selection of the main effects or factors affecting participation. Second, a stepwise selection of interaction terms was done based on the main effects variables in the model. Third, the final model was assessed through examination of goodness-of-fit statistics.

Since the study also focusses on the sustainability measures put in place for the use of solar tent dryers, the contribution of the community towards construction and maintenance of the dryers was included in the dependent variable in the logit regression model. Thus, the dependent variable (summarised in Table 4.1) captured a dichotomous outcome of whether a fish processor was using the solar tent drying method and whether they contributed to construction and maintenance of the dryer in their community. The two variables used were *Solar tent dryer users* and *Contributions made to construction and maintenance of dryers.* Only 13% of the sample responded that they were using the dryer and had contributed towards construction and maintenance of the same.

Table 4.1 Recoded dependent variable

Variable name	Variable label	Coding	Percentage (n=99)
Solar_participation	FPs participating in solar tent drying activities	Yes= 1 No= 2	13% 87%

From the qualitative data collected in phase one, potential variables were selected to predict which factors would increase participation in solar tent drying activities. Table 4.2 presents the potential variables, some of which were included in the logit regression model. Due to the small sample size (99), including all the variables would have over-fitted the model (Field, 2013). The potential variables were grouped into five analytical categories, namely the assets (capitals) depicted in the sustainable livelihood framework.

Table 4.2 Independent variables

Analytical category	Variable name	Label
Human Capital	Age	*Age*
	Gender	*Gender*
	Years of education	*EduYrs*
	Highest years of education in household	*HighHHEduYrs*
	Household size	*HHSize*
Physical Capital	Fish processing equipment	*Asset_fishgear*
	Own house	*Ownhouse*
	Livestock	*Lvtsk*
Financial Capital	Savings	*Svngs*
	Income (fish processing)	*OOincome*
	Income from other occupations	
Social Capital	Years of fish processing	*YearsFP*
	Years of solar tent drying	*YearsSD*
	Number of people trained in solar tent drying	*TrainedSD*
		TrainedContrct

	Number of people trained in solar tent dryer construction	*Ethnic*
	Ethnicity	*MigrateYrs*
	Years of migration (if not originally from Nkhotakota)	
Natural Capital	Access to firewood	*Accessfirewood*
	Number of woodlots	*Woodlots*
	Access to locally available construction materials	*MaterialAccess*

Even though the location of the FPs cannot be quantified as capital, the logit regression model included the variable *Village* as an independent variable. This showed that one of the main factors affecting participation were the different social dynamics within the two villages. The model included variables in the human capital category and the *Village* variable.

Two t-tests were used to assess the profitability of solar-dried fish against the traditional methods of fried and smoked methods, based on the selling prices in sample of the study. The objective was to determine whether the profitability of solar-dried fish would reduce the demand for fried and smoked fish, to reduce the use of firewood in fish-processing. Due to fish price fluctuation, data were collected on the selling price of solar-dried, fried and smoked *Copadichromis virginalis* (Utaka) and *Engraulicypris sardella* (Usipa) during peak and off-season periods.

4.4 Secondary sources

Secondary sources of data included SEED-Fish project reports, reports from solar-drying projects in Malawi, articles, books and other online publications.

4.5 Ethical considerations

Due to the nature of the study, there were no major ethical considerations that were expected to arise. The study was not overly political and did not include sensitive discussions, however principles of ethics were adhered to, especially since some of the information required anonymity and privacy, such as FP's level of income or the member of the BVC criticising their own committee. The main principles of research ethics are to avoid or minimise harm and

informed consent (Bryman, 2012) and these were strictly adhered to in the study. To begin with, a consent form was developed. The form contained the researcher's information as well as the scope of the research study. The consent form informed the participants or respondents that anonymity was stressed throughout the process, and that they were free to withdraw from the process, as their participation was voluntary.

4.6 Limitations of the study

Similar to most research studies, there were a number of limitations in the study. The biggest limitation was the fact that the tent in Chipala was not in use, a discovery that was only made during the first focus group discussion. Related to this, it was difficult to access project reports and information on the solar tent dryers from the project partners in Malawi. This meant that within the timeframe of fieldwork and limited resources, I had to rethink the data collection process. The initial plan was to administer the survey questionnaire to at least 50 solar tent dryer users in both Chipala and Vinthenga. However, on the days that data was collected in Vinthenga it was difficult to find solar tent dryer users, which leads to the second limitation.

Fish catches were low during the fieldwork period, and FPs were also involved in other occupations, with only 19 solar tent dryer users in the sample. As a result of low fish catches, there were few instances where I got to observe some of the processing methods. This was the case especially for the solar tent drying and smoking methods, for which observations were not made. The accuracy between observations of the other methods and the data collected from the FGDs sufficed to assume that the participants' responses concerning solar tent drying and smoking methods were also accurate.

Some of the data such as income, depended on recall methods, which risk exaggeration or underreporting of figures. The amount of fish sold in a week and the processed fish selling prices were used to check for exaggeration of figures.

4.7 Conclusion

In this chapter, I have outlined the methods and research design applied in the study. The study adopted a mixed methods research design to capture data that could best be collected using qualitative and quantitative methods. The mixed method approach assisted to minimise bias as well as test the data through a method of triangulation. To achieve this, a sequential exploratory

design was applied, where qualitative data were collected in phase one, which refined the household survey questionnaire administered in phase two. The data were analysed using thematic analysis as well as logit regression modelling and descriptive statistics, which altogether provide an in-depth understanding of how the introduction of solar tent dryers has affected the livelihoods of FPs.

CHAPTER 5: FINDINGS AND DISCUSSION

I have used descriptive statistics in this chapter to present and check the data obtained in the study. The descriptive statistics have also been used to assist in illustrating the findings with the use of simple statistics in the form of graphs. Throughout the chapter, I present the analytical results from both qualitative and quantitative data, graphically illustrated and tabulated to enable easier discussion of the objectives of the study. In addressing the study objectives, I have therefore presented and discussed the findings relating to issues of socio-economic characterisation, improvements of fish processing, sustainability, technology adoption and perspectives on gender implications, which have formed the major sections of this chapter.

5.1 Socio-Economic characterisation

In characterising the socio-economic status of fish processors in Nkhotakota, I present and discuss findings from pooled data from Chipala and Vinthenga fishing communities on their age and participation, household education levels, ethnicity, marketing strategies, saving culture and access to micro loans, income and poverty levels, and diversification of income sources, as outlined in the subsections below. The key variables used across these subsections are summarised in Table 5.1.

Age and participation

The data show that the majority (62%) of the fish processors in Chipala and Vinthenga were below the age of 30 (Table 5.1), indicating a high level of participation of young fish processors (FPs). This was corroborated by the SEED-Fish project staff and District Fisheries Officer (DFO) who further stated that this had a bearing on the communities' adoption of the solar drying method. Thus, it was expected that the older fish processors, due to their many years of experience using traditional methods, may not be as willing to adopt new methods as compared to their younger counterparts. Hence, 68% of solar dryer users were below the age of 30, whilst only 5% were above the age of 40.

Table 5.1 Descriptive statistics of key variables

Variable	Total sample (n)	Description	Frequency	Mean	Percentage
Human Capital		21 – 30	62	30.29 yrs	62%
Age (yrs)	99	31 – 50	36		36%
		51 +	1		1%
Gender	99	Male	17		17%
		Female	82		82%
Education (level)	99	None	9	5.84 yrs	9%
		Primary	77		77%
		Secondary	10		10%
		Tertiary	3		3%
Highest education in household (level)	99	None	3	6.95 yrs	3%
		Primary	75		75%
		Secondary	12		12%
		Tertiary	9		9%
Household size (headcount)	99	1 – 5	49	5	49%
		6 – 10	48		48%
		11 - 12	2		2%
Physical Capital					
Usage of dryer (times/week)	16	Once	2	3	13%
		2 – 3 times	11		69%
		4- 5 times	3		19%
Assets: Fish processing implements (number of implements)	81	Drying rack	44		
		Basin	81		
		Drying nets	31		

		Iron sheet	6		
		Reed basket	64		
		Spoons	14		
		Frying basin	15		
House value (MK)	83	No records	27	100785.22	32.5%
		5500 – 50000	23		27.7%
		60000-200000	19		22.9%
		250000-650000	14		16.9%
Livestock	47	Goats	16	2	34%
		Poultry	29	4	62%
		Pigs	2	1	4%
Financial Capital					
Savings (MK)	57	4000-10000	4	59984.18	7%
		12000-20000	6		10.5%
		25000-50000	22		38.6%
		54000-100000	16		28%
		11800-236000	8		14%
Income -fish processing (MK)	99	2000 – 10000	6	67,328.28	6%
		12000 - 30000	23		23%
		35000 - 60000	35		35%
		60500 - 100000	21		21%
		130000-200000	12		12%
		300000	1		1%
Income -other occupations (MK)	52	500 – 10000	18	59595.00	34.6%
		12000 - 30000	17		32.6%
		34000 - 60000	10		19.3%
		80000 - 130000	2		3.8%

		200000-300000	4		7.7%
		1500000	1		1.9%
Social Capital					
Years of fish processing	97	6 – 12 months	12	7.58 yrs	12%
		1 -5	51		51%
		6-10	19		19%
		11-14	6		6%
		15-29	5		7%
Years of solar drying	19	3 – 12 months	5	0.74 (less than a	26%
		One year	14	year)	73%
Membership in BVC or SDC	99	Members	15		15%
		Non-members	84		84%
Number of people trained in solar drying	19	Trained	0	0	0%
		Not trained	19		100%
Number of people trained in solar dryer construction	19	Trained	0	0	0%
		Not trained	19		100%
Ethnicity	99	Chewa	84		84%
		Tonga	4		4%
		Yao	1		1%
		Lomwe	3		3%
		Tumbuka	5		5%
		Sena	1		1%
		Mang'anja	1		1%
Years of migration (if not originally from Nkhotakota)	10	1 – 10	6	15 yrs	60%
		11 – 20	1		10%

		20+	3	30%
Natural Capital				
Distance to firewood (km)	99	0.5 - 5	99	100%
Access to locally available construction materials (km)	99	0.5 - 5	99	100%

Household education level

The average years of education that fish processors had attained was 5.84 (Table 5.1), which indicates that most of them (77%) had only attained primary education. The Malawi school education cycle (yrs) is in three categories: years 1 to 8 of primary level, years 9 to 12 of secondary level and years above 13 of tertiary or higher education level. The differences in fish processors' level of education were not significant *($\chi 2 = 10.756$, $df = 13$, $p = 0.631$)* with participation in solar drying activities, which means that the level of education did not influence their decision on whether or not to participate in solar drying activities. On further exploration of the effect of level of education, I included the variable *"highest education level in the household"* to assess whether there were individuals in this category in any of the fish processor's households and determine if these affected or influenced the household dynamics in decision-making to participate in solar drying activities. However, the highest education level in the household did not significantly affect the participation in solar drying *($\chi 2 = 13.898$, $df = 14$, $p = 0.457$)* with fish processing incomes**,** thus the assumption made was that the fish processors' enterprise was not directly affected by the education levels of other members of the household. Furthermore, two FPs with the highest fish processing income (MK 300,000) had only attained primary level education for only 4 and 8 years respectively.

Ethnicity of fish processors

The majority (84%) of the sampled fish processors belonged to the Chewa ethnic group, which is representative of the dominant ethnic group in Nkhotakota. The SEED-Fish project staff and the DFO had expressed that one of the differences between the two villages was the fact that there were many migrant fish processors in Chipala, and thus the members of the community did not share similar values to participate in development work as the community in Vinthenga. However, as shown in Table 5.1, the sample included only few other migrant fish processors (of 6 ethnic groups), unlike what was indicated by the SEED-Fish project staff and the DFO in the qualitative data. The data show that the migrant fishers' perceptions, as shown by the years of migration in Table 5.1, were similar to those of the natives, probably because they had lived in the communities for many years, averaging 15 years (n, 10).

Income and poverty amongst fisherfolk

To understand the socio-economic status of the respondents, the study sought the perceptions of the FGD participants on income and poverty. This exercise assisted in identifying which group of fish processors in the community were well-off or poor. Participants from Chipala explained that a well-off person is someone who has fishing gear, and also has other businesses

that they can depend on should fish sales be low. However, the participants classified most fish processors as poor because they do not buy large amounts of fish. Thus the FGD on traditional methods revealed that most regarded a poor person as one with many needs but with no means. For example, one may either want to have a business but does not have capital to start the business or they do not have enough money to buy food.

The focus groups in both Chipala and Vinthenga explained that fish is, therefore, normally bought in groups due to the requirements by fishermen and cost of the fish which is too expensive for individual fish processors. In this case, the fishermen aim to sell fish as fast as possible and thus sell their fish at a wholesale price. For example, the fish processors may buy fish from one fisherman at K200,000, with each one of them contributing between K10,000 and K20,000 to that amount. Then they split the fish according to how much they contributed towards the wholesale price.

A group of FPs who only use traditional processing methods expressed that it is mainly those who are employed with steady jobs that are regarded as well-off, and not persons involved in fisheries. To justify this, they referred to the unpredictable and unsteady weather patterns at the time of data collection, which resulted in fish being scarce, making it difficult to get a steady income from fish. For similar reasons, a group of women explained that their capital gets lower and lower because they mainly depend on the lake for their income. Thus, the general perception was that those who are well-off are those who are employed and can be teachers, nurses, and maybe those who have big businesses. These findings correspond with results from other studies that show that fisherfolk are poorer than other rural dwellers, with some suggesting that fisherfolk are the poorest of the poor (Allison and Mvula 2002), Smith, 1979; Christy, 1986; Pauly, 1997), though this was not the case in my study.

A more recent study in the Lake Chilwa Basin, however, revealed that fisheries attracted an annual income of USD 1 million. There were no comparative statistics for Nkhotakota on the annual income from fisheries. However, in Chipala and Vinthenga the groups described fish processors who are well-off as those who buy 20 or 50 dozen of fish and sell them outside of Nkhotakota, for example, in Lilongwe the capital city. Though there was no readily available information of annual incomes from such sales, the general perception, as expressed by one female participant, was that such people are well off as they generate a lot of money, whilst the rest of them make around MK10,000 to MK20,000. The data (Figure 5.1) shows that 29% of the sample had fish proceesing incomes of between MK 2000 and MK30,000, which did not correspond with the female participant's statement.

In addition, the women expressed that some of the assets that well-off persons in the village possess are goats, fridges, dishes, TV satellite dish, video players, houses with corrugated iron sheets, as compared to thatched houses which are common in the village. Asked under which category FPs fall, the same female participant responded with some despondency:

"Ah 3 quarters of us…ah…there is none who is well off. It is only those that I have mentioned, who buy chambo, are the ones who are on top." Traditional methods FGD, Chipala

The traditional methods FGD participants differentiated between the poor and the poorest, saying that those who are poorest have no occupation, business or capital to start a business. The poorest lack adequate food, struggle to find food and mostly only have food after they have earned money from piecework. Some of the piecework is to help fish processors with drying fish or washing nets. One woman in Chipala, for example, expressed that such piecework, such as assisting in smoking fish, done by the poor may only attract a payment of MK500.

It was interesting that when asked to define who is poor the participants did not immediately categorise themselves as poor but described the poorest first. For example, when the men in the Solar drying method FGD were asked if fish processors were poor or well-off one responded by saying,

"Someone who has a business? No! A business person can be poor, but this poverty has different grades."

In Vinthenga the women in both FGDs echoed the same sentiments, by indicating that there were groups who can be categorised as the poorest, the poor and the not so poor. But when asked if they, as fish processors, could consider themselves as poor, the response was that of laughter, as they did not regard themselves as such in as long as they had food and money from their fish sales to buy food. However, even at that they could not describe themselves as well off.

Diversification of income sources

The fish processors said they also engaged in some small-scale businesses, but which could not compare to the fish processing business in terms of income. To verify this, I compared the respondents' incomes from fish processing and from their other sources of income. The average contribution of fish processing to the total income of the respondents was 83%, though with a range of between 2 and 100%. Further, in determining income diversification, I used Simpson's diversity index (Simpson, 1949) to measure the extent to which sources of

income are diversified. The index ranges between 0 and 1, with 0 indicating no diversification of the total number of sources of income from one entity, and 1 being the highest level of income source diversification. The index uses the formula below where:

D = Simpson's diversity index

n = the number of sources of income per respondent, and

N = the total number of sources of income of all respondents.

$$D = 1 - \left(\frac{\sum n(n-1)}{N-1} \right)$$

Using this formula, diversity was measured at 0.98 which showed that the incomes were highly diversified (see Appendix 6). Figure 5.1 shows the other occupations that the respondents had.

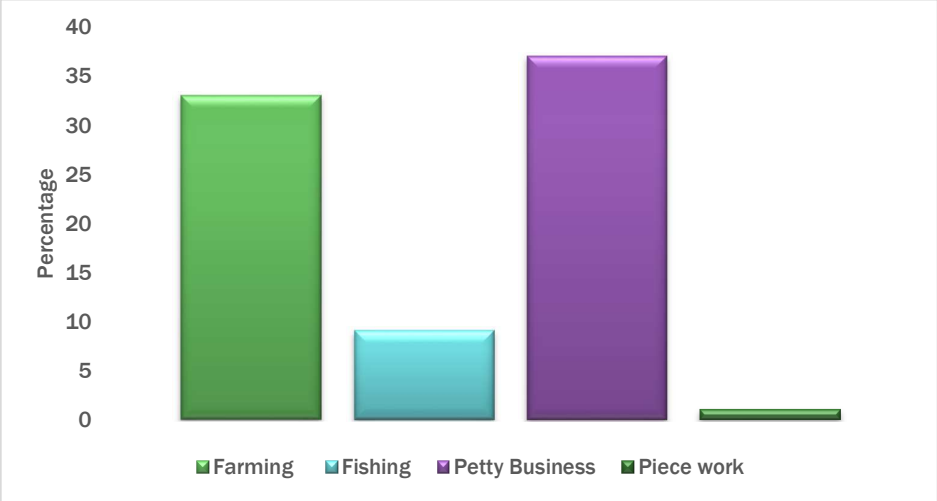

Figure 5.1 Fish processors' other occupations

Further, I assessed income from fish processing against income from other occupations to determine which of the two contributes the most to the total income of fish processors. With sources of income being highly diversified, the results correspond with the findings of Allison and Mvula (2002) which show that, due to reduced opportunities in fisheries, fisher folk are more involved in opportunities elsewhere. However, it was noted that while the respondents' sources of income were highly diversified, the majority of their income came from fish processing (Appendix 7).

5.2 Improvements of fish processing with solar dryers

Fish processing value chain

The findings indicate that besides the fish processors adopting the solar drying method, the value chain has not changed as the participants expressed that their roles have remained the same, thus mainly processing and marketing of fish. There are however, differences between the two villages that affect fish processing. In Vinthenga the fish processors (FPs) buy fish a few metres from their dryer, whereas there is approximately 100 metres from the point of sale to the dryer in Chipala. The FPs wash the fish with water from the lake and place them on the trays in the dryer. The preparatory stages for fish processing include having enough money to buy the fish, and having nets ready to dry the fish in the tent, which must be cleaned before use. The fish processors spend a lot of time negotiating prices with the fishers. Figure 5.2 shows fish processors buying fish from fishers who had just docked at Kariba beach, which is the fishing dock between Chipala and Vinthenga.

Figure 5.2: Fish processors buying fish from fishermen who had just arrived from fishing at Kariba Beach, Nkhotakota (Source: Fundi Kayamba-Phiri)

At times it took over an hour before they agreed on a price and for the fishers to release the fish. Thereafter, the fish is dried and taken to the fish market the following day, where they sell the fish themselves. Using the open-sun drying method, 2 to 3 FPs can dry their fish on one drying rack at the same time, depending also the amount of fish they have bought. One rack takes up to 4 *Arkays* (20 litre blue basin in Figure 5.3). Sometimes FPs buy an *Arkay* together and split the fish in half, or three parts. Figure 5.3 shows a fish processor selling one bucket of fish from a drying rack.

Figure 5.3 Fish processor selling open sun-dried *Engraulicypris Sardella* (Usipa) in a 5kg bucket (Source: Fundi Kayamba-Phiri)

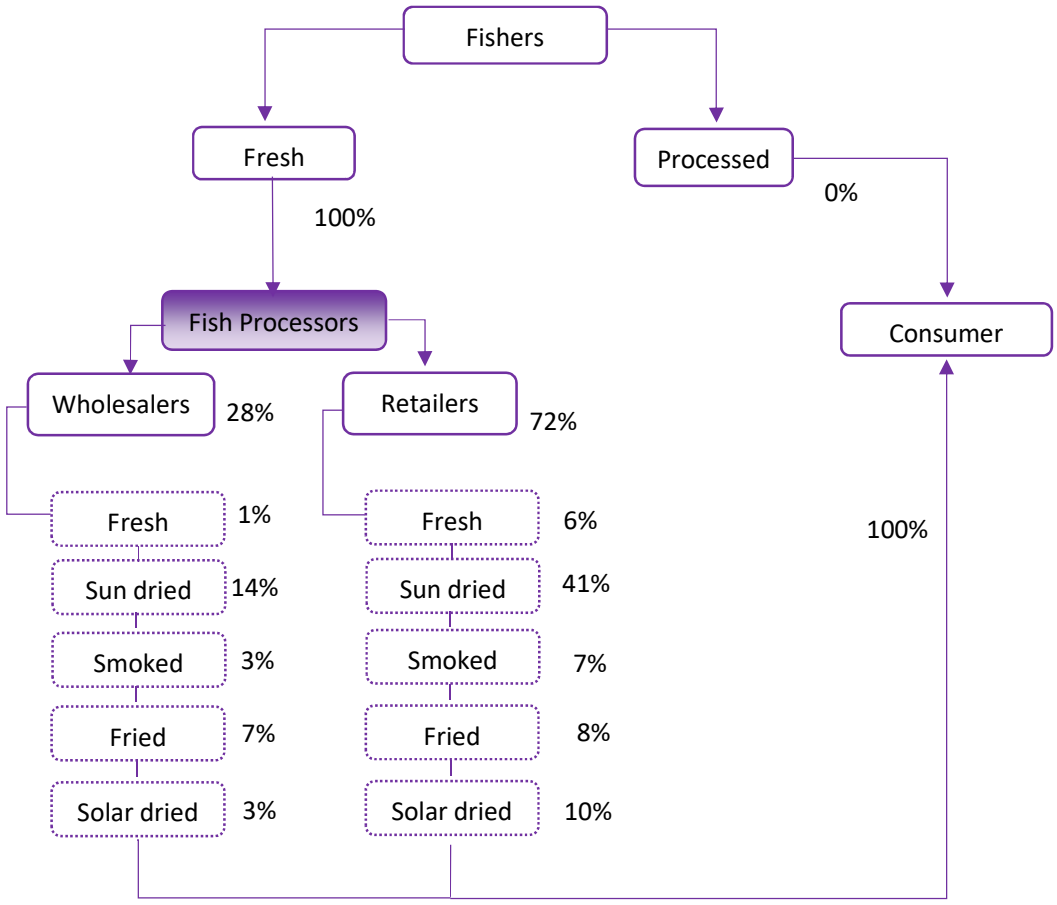

Figure 5.4: Distribution proportions of post-harvest methods for *Copadichromis virginalis (Utaka)* and *Engraulicypris sardella* (Usipa) in Chipala and Vinthenga (n,99)

As presented in Figure 5.4, the results (n, 99) show that only about 28% of the fish bought from fishers is sold by wholesalers, while 72% is sold by retailers. The proportions per processing

method (Figure 5.4) are based on the method that a respondent used the most, which indicated that though fresh fish is preferred, there are few FPs who solely sell fresh fish. In this case, both retailers and wholesalers are fish processors, even though not all wholesalers are fish processors. The analysis also shows that wholesalers sell their fish in markets outside of Nkhotakota, while the retailers sell their fish either in the local market or their homes. Only 3% of the fish processed using the solar drying method is sold by wholesalers, which shows a minimal exposure of the method to markets outside of Nkhotakota. Within Nkhotakota, solar-dried fish constituted 10% of fish sold processed. The bulk (56 %) of the fish caught was sold sun-dried.

Marketing strategies in Chipala and Vinthenga

The cross-tabulation of data on the place of sale and processing methods (Table 5.2 and 5.3) confirm that these were influenced by the location (village) of the respondents. Thus, when asked if there were any differences in the processing methods used in the two villages, the traditional methods group in Chipala expressed that the difference was in the location of sale and processing methods, with one of them stating as follows:

Table 5.2: Cross-tabulation of Village and Place of sale

		Place of sale				
		Nkhotakota	Lilongwe	Kasungu	Salima	Total
Village:	Chipala	38	6	8	2	54
	Vinthenga	34	1	3	7	45
Total		72	7	11	9	99

N=99, *(p* =.000)

"Processors from Vinthenga buy Usipa and the thing is that most people will go to buy the fish from their village. On the other hand, we buy bigger fish and sell our fish fresh, mostly. And we sell our fish in the market. Most of the dried fish from Vinthenga is not sold in the market." Female participant, traditional methods FGD, Chipala

Table 5.3: Cross-tabulation of Village and Processing Methods

		Customer-Preferred Processing Methods						
		Fresh	Solar drying	Sun drying	Parboiling and sun-drying	Smoking	Frying	Total
Village:	Chipala	13	1	23	7	1	9	54
	Vinthenga	9	17	16	1	1	1	45
Total		22	18	39	8	2	10	99

N= 99 (*p* = .044)

Saving culture and access to micro-loans

The fish processors in the study were members of village banks, as well as *chihandi*, in other words, members belonging to micro- savings and loans groups, while some indicated having savings with formal banks (Figure 5.5). *Chihandi* is a simpler system as compared to village banks, as members of a group agree to contribute a certain amount per day and the whole amount is given to one member of the group every day. The village bank is more involving because every week the group meets and buys a maximum of five shares. During the weekly meeting members are also allowed to take loans from the group with a maximum of 20% interest.

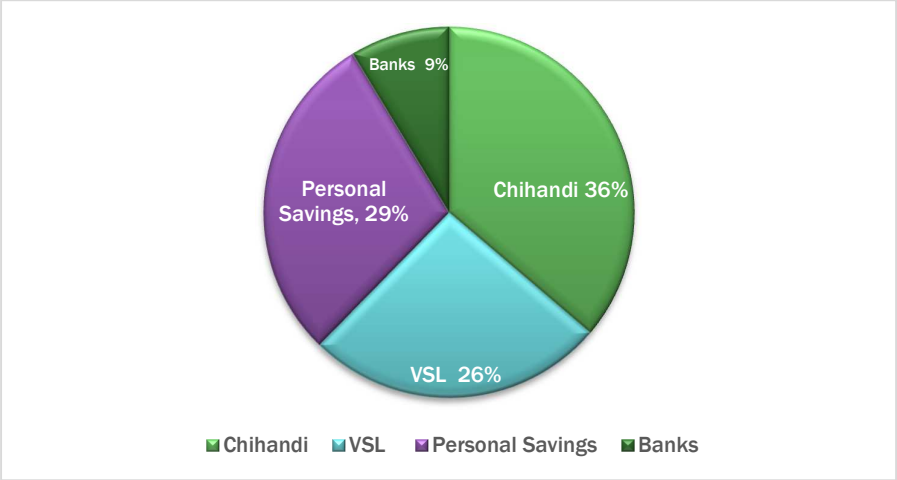

Figure 5.5 Fish processors' saving methods

The fish processors stated that the village banks serve as safety measures when they have lost their capital from their processing business. The money that they saved in the village banks was mainly from their fish processing business. They expressed, however, the desire for microfinance institutions where they could access loans to invest in other businesses that would serve as an alternative when fish is scarce.

Interestingly, there were very few men in village banks. The reason was that men were often regarded as deceptive and highly capable of stealing from the groups. The only man in the group at Vinthenga explained this. Generally, the FPs sometimes use money from *chihandi* and settle their loan with the village bank. Despite some of the issues about the behaviour of men concerning money, some women expressed that their husbands gave them the capital to start or continue their business. Another man stated that he gave his wife money to save in the village bank.

The findings correspond with the literature that 'savings culture' rarely exists in fishing communities due to two main factors. First, there is a perception that there is always fish to catch if they need money, which is a culture element. Second, options to save through financial organizations are limited (Ardjosoediro and Neven, 2008). Though there are microfinance banking opportunities, the options available in the two communities are small and designed for communities or individuals with small incomes. The average income in the sample, of about half the population of FPs, was MK 67,328.28. The regulations within systems such as village banks entail that persons are restricted to a certain share or loan limit, which might not be the case should they have access to loans from microfinance institutions.

The study focussed on the methods used to process different fish species. The questionnaire included 12 fish species that are commonly caught and sold in Nkhotakota. The data revealed that the two most common fish species sold by the respondents are *Copadichromis virginalis* and *Engraulicypris sardella,* locally known and hereafter referred to as *Utaka* and *Usipa*. Table 5.4 shows the number of fish processors that process each of the other 10 fish species beside Utaka and Usipa.

Table 5.4: Common fish species processed by fish processors in the sample

Species	Number of FPs processing the fish species
Copadichromis virginalis (Utaka)	56
Engraulicypris sardella (Usipa)	57
Bagrus meridionalis (Kampango)	4
Synodontis njassae (Nkholokolo)	6
Rhamphochromis spp (Mcheni)	9
Diplotaxodon ecclesia (Ndunduma)	13
Opsaridium microcephalum (Sanjika)	5
Oreochromis spp (Chambo)	2
Clarias gariepinus (Mlamba)	10
Aulonocara gertrudae (Mbaba)	16
Bathyclarias nyasensis (Bombe)	2
*Lethrinops gossei (*Chisawasawa)	17

For Utaka and Usipa, the methods used by fish processors are illustrated in Figures 5.6 and 5.7. In general, the figures illustrate that fresh and sun-dried fish are the most commonly sold from Chipala and Vinthenga. Solar-dried fish was the third most commonly sold fish at 12%.

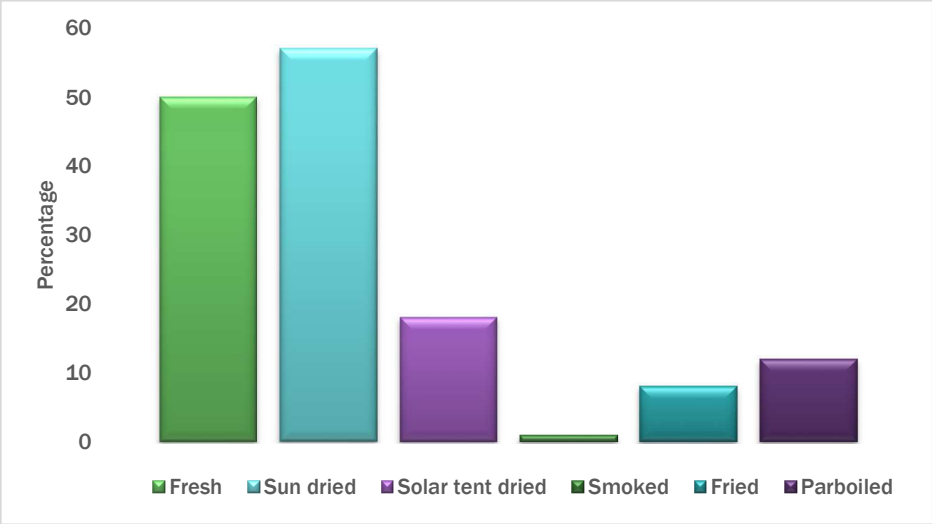

Figure 5.6: Distribution of processing method used for *Engraulicypris sardella* (Usipa) (n,57)

The low rate of solar-dried fish can partly be attributed to the small number of respondents using the solar dried method. However, this represents half of the population in Vinthenga, upon which assumptions are based. The high percentage of fresh Utaka and Usipa corresponds with the qualitative data which indicates that FPs would prefer more ice machines that would improve the quality and preservation of fresh fish.

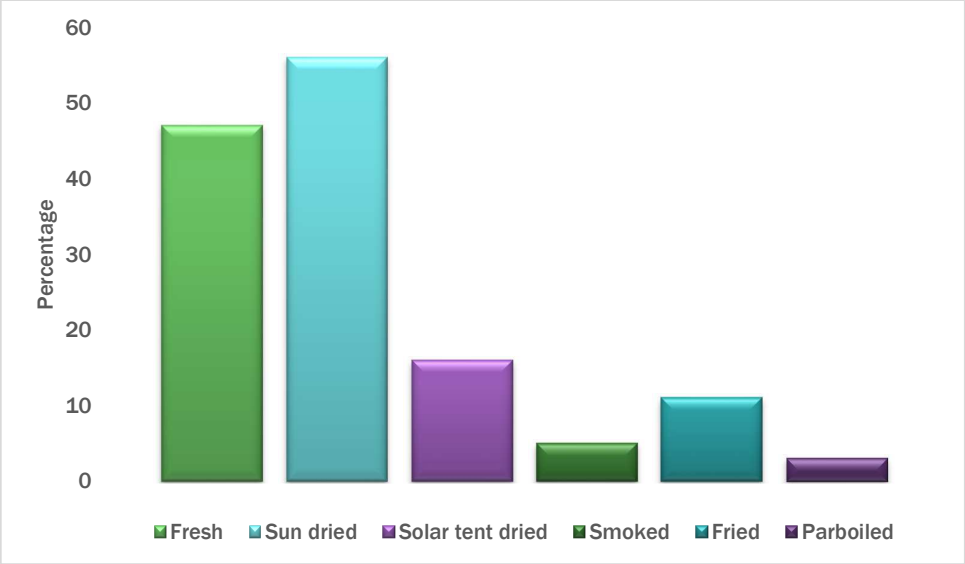

Figure 5.7: Distribution of processing method used for *Copadichromis virginalis* (Utaka) (n.56)

Benefits of the solar drying method

Fish processors in both villages appreciated the improved quality of dried fish using the solar drying method. The participants expressed that the customers will always buy the solar dried fish first because of the brighter colour that is more appealing. The solar tent drying participants also appreciated the difference in taste by comparing solar-dried and open sun-dried fish. Sun dried fish had a mild sour taste, whilst the solar tent dried fish did not because the drying process was even, in drying the entire fish. Yean *et al.* (1998) discuss similar disadvantages of using the open sun drying method, as the fish is exposed to contamination as well as insect attack. Furthermore, they state that open sun drying is seasonal and that affects the quality of the product. Within seasons, however, as expressed by the participants, the fish must be exposed to enough heat from the sun to dry evenly, which seldom happens. Thus, the use of the solar dryers ensures that the heat captured in the tent is evenly distributed. Because of the better quality in the solar tent, the fish is more expensive than sun dried fish by K500, normally representing a 13 to 15% increase in the price of a bucket of fish.

In terms of time, the solar dryers did not only shorten the time it took to dry fish, but also reduced the activity of the food processors during the drying process. The solar tent drying FPs explained that it took 2 to 3 days to dry fish using the open sun dried (OSD) method, whilst with the solar method it took a day. The FPs do not need to check or turn the fish whilst it is in the solar dryer. Open sun-dried fish is turned at least 3 times on drying racks. Solar-dried fish also sells faster in the market because of the quality of the fish, allowing FPs more time to perform other household duties.

None of the participants in Vinthenga used the smoking or drying methods, as confirmed through the survey. Since there were no solar tent dryer users in Chipala, the difference in the time spent processing using different methods could not be estimated. However, during the observations in Chipala it was noted that the frying method was time consuming. The processor needed to prepare the fire and the basin with cooking oil. Finally, the frying process took 30 minutes on average for 50 fish (Utaka). Part of the frying process is shown in Figure 5.8, with the final product in the red basin on the left.

Figure 5.8: A fish processor frying *Oreochromis karongae* (Kasawala) (Source: Fundi Kayamba-Phiri)

Figure 5.9 shows the perceptions of FPs (n,99) on which methods were perceived as most time efficient. The data shows that sun-drying was the most time-efficient method, whilst fresh fish was ranked second.

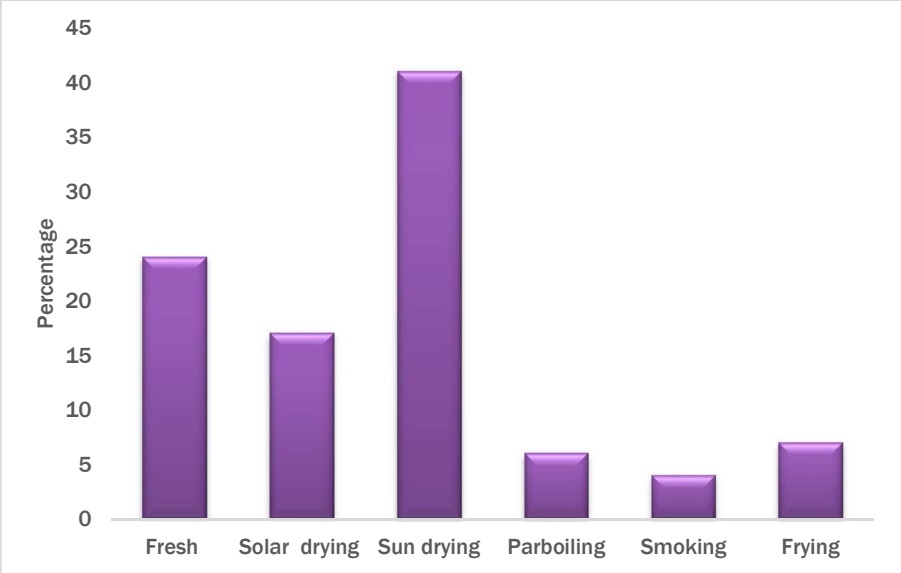

Figure 5.9 Perceptions of the most time-efficient method (n,99)

Transportation of fish was at a standardised price but varied depending on the amount of fish that a FP was carrying to the market. The FGD participants expressed that transportation depended on whether the fish was carried on their head or on the bicycle carrier, with the latter attracting an extra cost of a MK 100. Also, the total price depended on the sales they had made

in the market, because if their sales were low they would need to transport the fish back to their homes. The average transportation cost within Nkhotakota was MK 305.55 whilst MK 6850 was the average cost for FPs trading outside of Nkhotakota.

The process of selling fresh fish involves buying the fish from the fishermen, buying ice blocks, packaging the fish and taking it to the market. As the participants compared the different methods they concluded that the frying method was the most expensive in terms of materials used. To process fried fish, one must have a set of materials. The FPs either own, borrow or hire these materials depending on their income. The materials include, a big steel basin used for frying, two big steel spatulas, and a flat reed basket for removing the excess oil from the fish.

The groups estimated the requirements for frying 10 kgs (2 buckets) of small fish species, Usipa and Utaka. The list included: 10 bundles of firewood costing MK 1000, 5 litres of cooking oil. The cost of the requirements alone came to MK 5000, compared to the requirement for fresh fish, which is ice at MK 1000. One participant stated that frying the fish, however makes the fish last longer, as compared to buying ice daily to preserve the freshness of the fish. This corresponds with the literature, as the frying method requires a high temperature of between 160 and 170 degrees Celsius (Rossel, 2001). The process may degrade nutrients but at the same time improve quality of the fish in terms of flavour, which the participants expressed was the main attraction to fried fish (Rossel, 2001). Further, the cooking oil is overused which may cause health-related risks. Figure 5.10 shows three bottle of cooking oil, with a greasy colour, that were being used by a participant.

Figure 5.10: Bottles of recycled cooking oil used for frying fish (Source: Fundi Kayamba-Phiri)

The cost for firewood was the same in both villages, at MK100 per bundle of three small pieces of wood. The dimensions of the bundle was estimated to be 2 cm^2 and 40 cm long. For 50 to 200 fish, the FPs estimated 10 bundles of firewood required for using the frying method. The smoking method used more firewood, with double the amount of firewood for the same amount of fish. However, for species such as *Oreochromis spp* (Chambo) the FPs expressed that more firewood is used, even though they could not estimate, as none of them sold smoked Chambo. Figure 5.11 shows the fish processors' preferred methods, with few FPs stating a different method than the method they perceived as the most time-efficient (Table 5.9). Processing methods were preferred based on the best quality fish (44%), time efficiency (31%), minimal cost of inputs (19%) and customer's preference (6%). Respondents who preferred the solar drying method indicated that this was so because of time efficiency. However, the analysis also shows that not all solar dryer users perceived the solar drying method as a preferred method.

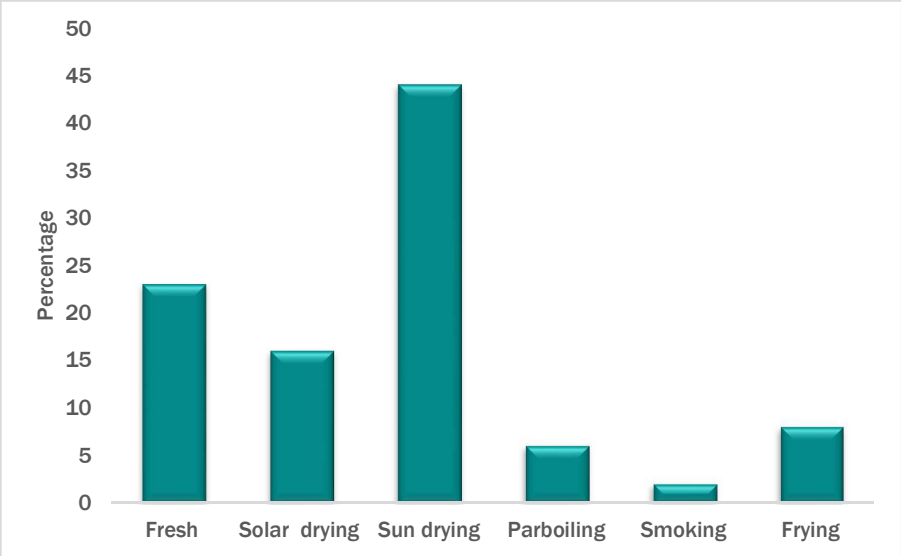

Figure 5.11 Fish processors' preferred methods (n,99)

Another advantage of using the dryer is reducing the fish losses during the rainy season, when a lot of fish goes bad. Using the dryer achieves the project's objective of reducing post-harvest losses that are associated with climate variability, with prolonged rainy seasons that affect fish processors' income. One female FP who had used the dryer in Chipala appreciated the fact that while FPs might not be able to use the dryer every time it still reduces post-harvest losses during the rainy season.

Supply and demand for smoked and fried fish

Despite the benefits of solar dryers, the participants expressed that the profit was marginal because of the inconsistent usage of the dryer, as well as the fact that there still was some

demand for smoked and fried fish. The FGD participants attributed this demand to the distinct taste of such fish. Figure 5.12 illustrates the customer preferred methods, as perceived by the respondents. This shows that the demand for smoked and fried fish was not as high as that of sun dried, fresh and solar dried fish, which underscores the greater importance of the latter methods.

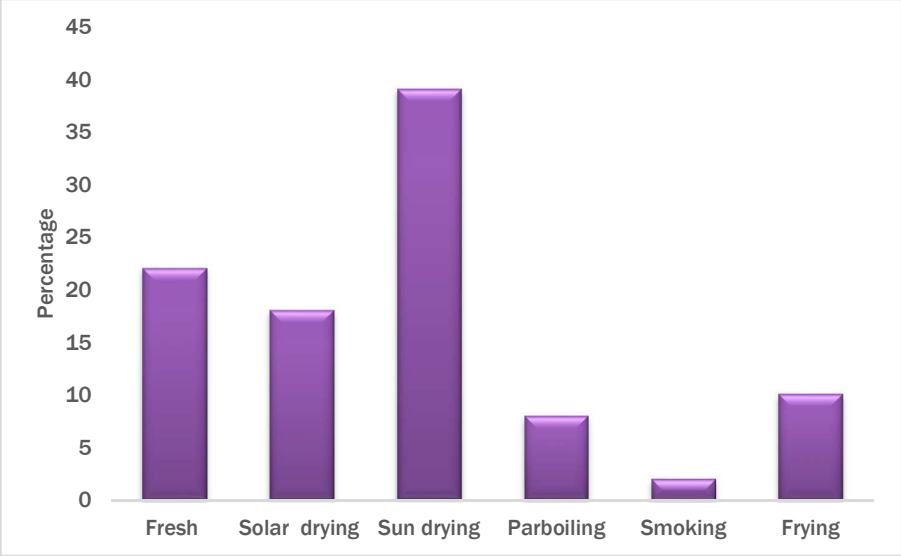

Figure 5.12 Customer-preferred methods

To understand the supply and demand of smoked and fried fish, selling prices were also assessed. Tables 5.5 and 5.6 are results from one sample t-tests comparing the means of 4 processing methods. Sun dried prices were included because the method is closest to the solar drying method and requires similar resources. For both peak (Table 5.5) and off-peak periods (Table 5.6), the analysis shows that, respectively, the most expensive bucket of fish is fried, with a mean of MK 6960 when fish catches are high and MK 8535 when fish are scarce. Second to fried fish was smoked fish, followed by solar dried, and lastly sun dried. Solar dried fish is shown to be more profitable than sun-dried fish.

Table 5.5 Means of processed fish prices (MK) during peak season

Selling prices/method during peak season

	N	Mean	Std. Deviation	Std. Error Mean
Sun dried	84	3952.38	1183.77	129.16
Smoked	15	5333.33	3045.29	786.29
Fried	20	6960.00	2115.21	472.98
Solar dried	18	4183.33	1862.72	439.05

In terms of demand, with the smoked and fried fish being the most expensive, this implies that there is greater demand for use of the two methods. Since the inputs of such methods are higher as compared to all the other processing methods, the higher prices are determined by and are reflective of the inputs needed. However, after deducting the cost of processing, fried fish was still the most profitable at 25% during peak season, and 21% during off season (Appendix 8). Solar dried fish had a profit of 20% during peak season, and 11% off season.

Table 5.6 Means of processed fish prices during off season

Selling prices/method during off season				
	N	Mean	Std. Deviation	Std. Error Mean
Sun dried	84	5625.00	1426.67	155.66
Smoked	15	7133.33	2837.67	732.68
Fried	20	8535.00	2008.73	449.16
Solar dried	18	5500.00	1823.05	429.69

Fish processing and deforestation

Perceptions

The participants explained that most forests had been depleted in the study sites because of firewood production. Deforestation was also attributed to over population, with encroachment into the forest for housing exerting pressure on the forests and thereby replacing tree cover in the two villages. One female participant expressed how there was no space for her to plant trees even if she wanted to. The District Forestry Officer described charcoal production, timber production and firewood production as the major drivers of deforestation in Nkhotakota. Though deforestation figures were not available at the time of the interview, he however claimed that the contribution of fish processing to deforestation was not as significant as the above three prominent drivers.

On the contrary, the District Fisheries Officer indicated fish processing as one of the prominent drivers of deforestation. For this reason, the fisheries policy encourages the use of smart technologies that use renewable energy as one way of combatting deforestation. Fish processing is thus well-reflected in the fisheries policy, though there is little detail on the use of renewable energy and mechanisms for monitoring the prevalent wood consumption by the Fisheries Department are not in place. This is reflective of the inadequacies of a holistic approach in

dealing with deforestation for even one of the SEED-Fish students, who investigated fuel efficiency in fish processing, did not include an assessment of wood consumption.

An investigation on the perceptions of the fish processors on the drivers of deforestation in their areas (Figure 5.13) shows first, that 15% of the respondents did not believe that there was deforestation in their areas. The reasons given were that there were re-afforestation efforts in the areas, laws that prohibited careless cutting of trees and corresponding fines, and that the forests were well taken care of. During the FGDs it was expressed that even though the firewood could be purchased close to the processing sites, the firewood was not produced from either Chipala or Vinthenga and that it was transported from further parts of Nkhotakota such as Sani. None of the respondents indicated having their own or associated woodlots. Of the 84% who indicated that their areas had been affected by deforestation, the reason given by most of them (74%) (Figure 5.13) was that this was due to charcoal production as the most prominent driver of deforestation. The agrees with the findings of Kambewa *et al* (2007), who stated that due to the lack of adequate electricity in Malawi, charcoal, which serves as one of the main sources of energy at household level, is a major driver of deforestation.

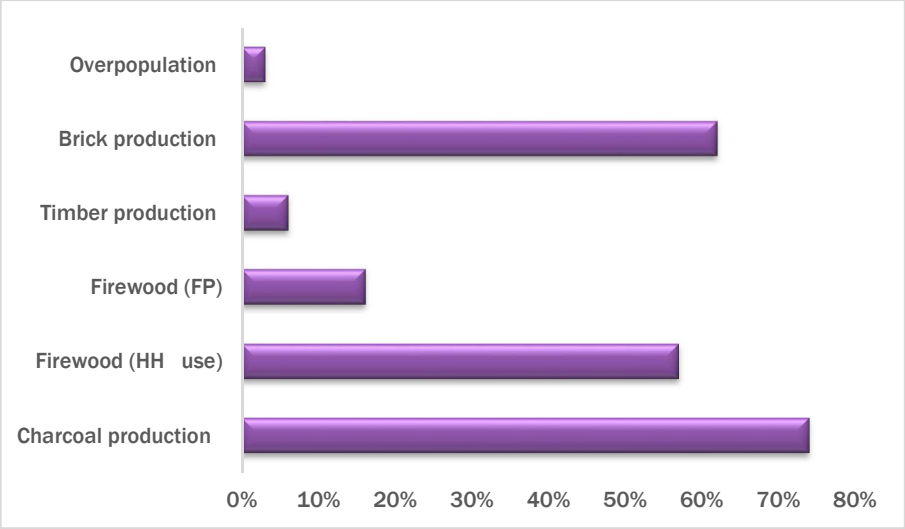

Figure 5.13 Perceptions of fish processors of the drivers of deforestation

Furthermore, the perceptions on fish processing as a driver of deforestation (Figure 5.14), shows that the 26% of the respondents perceived fish processing either as a possible driver of deforestation or a driver with minimal contribution to deforestation. 23% however, strongly agreed that fish processing was a driver of deforestation, which was attributed to the fuelled methods that use a lot of firewood.

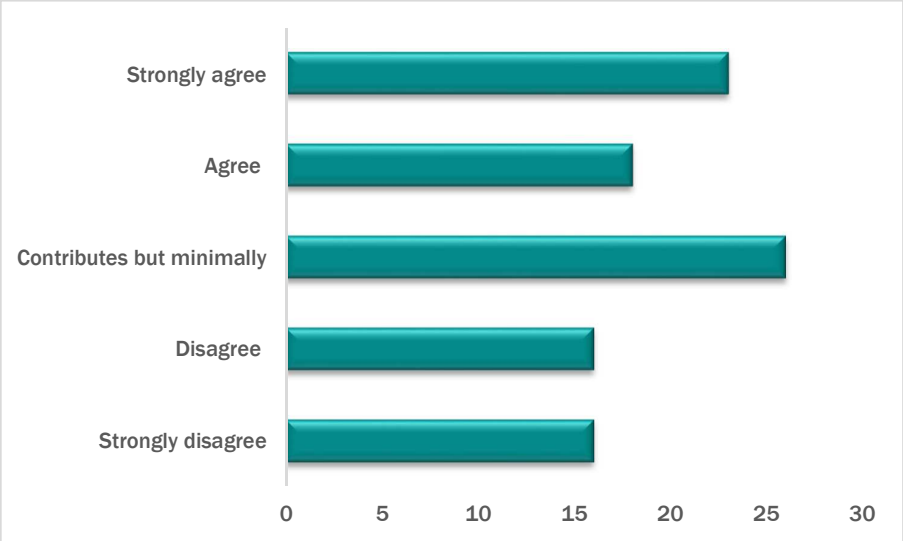

Figure 5.14 Perception of respondent of the statement that fish processing contributes to deforestation in Nkhotakota

Collaboration between the Fisheries and Forestry Departments

The results of interviews conducted in the study shows that there was collaboration between the fisheries and forestry offices, however, not under the SEED-Fish project. Most of the collaboration between the two departments depended on the person in office, with some officers more open to collaboration than others. The DFO gave an example of the two departments having developed project proposals together which the SEED-Fish project staff were not aware of and further indicating that the staff had not dealt with forestry officers since the beginning of the project. It was further expressed that the DFO was better placed to respond to the question of collaboration between the two departments, adding that that none of the people from MZUNI and LUANAR had met the District Forestry Officer. The general view, however, was that the Forestry Department would have been engaged if the SEED-Fish project also included reafforestation. Furthermore, the DFO stated that there was no collaboration between BVCs and VNRMCs in the two villages and Nkhotakota, which was also confirmed by other forestry and fisheries officers. However, the DFO stated that collaboration between BVCs and VNRMCs existed on paper.

5.3 Sustainability measures

Participation

According to the District Fisheries Officer (DFO), adoption of the solar drying technology was the main challenge in the project, especially in Chipala. There were conflicts between the BVC and the rest of the communities concerning ownership which affected the level of participation in the community. The DFO suggested that more interviews with community members would

assist to understand the gravity of the conflict. He expressed that in Chipala the community did not contribute anything. They were paid for everything; ferrying water, bricks and all other materials. The project staff expressed that he had to pay K500 per person for the committee to mow the grass in preparation for visitors who were coming from Norway towards the end of the project.

From the discussion with the female FP who had used the dryer in Chipala, the people in Chipala who were involved in the early community meetings were not fish processors, and had limited knowledge about fish processing. One of the reasons for low participation that was mentioned in both FGDs in Chipala was the location of the dryer. The fact that the dryer was constructed a distance from the dock and on the Fisheries Department's premises, made it difficult for the community to assume ownership, as they were not involved in the choice of the site.

The DFO explained that the reason for having the dryer on Fisheries Department property was because the government had a "stake" in the project, which meant that they could offer their premises for the project. The research unit of the Fisheries Department also wanted to use the technologies for research purposes, whilst the communities were also using them. There are two different improved kilns at Chipala, which is also different from Vinthenga, where only the dryer was constructed.

The idea was that Chipala would be the hub for these technologies, though they have not been utilised by the community. The DFO described Chipala as the "legitimate children" and defended the decision to construct the dryer on the Department's premises by stating that Government does not own land, rather it belongs to the people and therefore, in a democracy, the people are the Government. He felt that the wrong committee was governing the 'tent' but, in any case, the coin has turned and Vinthenga is the success story.

The DFO focussed on how participation in Chipala had been influenced by the interaction between the BVC and the community at large. The price for using the dryer was set by the BVC because they believed that managing the dryer was their responsibility, without consulting the community. They assumed that they were in charge, which is not the same in Vinthenga, where a sub-committee was formed specifically for the management of the dryer, and most of the members are fish processors themselves; in Chipala the BVC is mostly comprised of men, and therefore also not fish processors. As a solution, the BVC expressed that the dryer could be used by commercial fishers who use trawlers.

Based on the above differences, community participation was stronger in Vinthenga than in Chipala. The DFO further stated that the age of those involved is also different; the BVC chairman in Vinthenga is younger than the BVC chairman in Chipala, which makes Vinthenga more active and vibrant. The security of the tents is also different: people in Vinthenga leave their fish overnight in the dryer, whereas the same cannot be done in Chipala. The door of the tent in Chipala was stolen shortly after installation (Figure 5.15).

Figure 5.15 The solar tent dryer at Chipala without a door (Source: Fundi Kayamba-Phiri)

The DFO also pointed out the differences in the roles of traditional leaders in Chipala and Vinthenga. The village headman in Chipala controls the BVC. However, from the interview with the village headman in Chipala, I gathered that the village headman was not fully aware of the SEED-Fish project and also did not participate directly from the onset of the project. Asked about the preparatory stages of the project and what role she had played throughout the project she expressed that:

"Eh (shrugs) they [the project officers] had called for a meeting to tell us about the project, so I agreed and told the BVC to inform everyone about it, especially the youth, since those are the people who are involved in development. So I left it to them." Village Headman (VH), Chipala.

The VH was aware that the dryer was not in use, but could not provide an explanation for it, and thus did not think she had any solutions for the problem. The village headman in Vinthenga, however, took a different approach by being involved in the different phases of the project. The identification of the site was done by village headman, who also supervised and assisted in the

construction of the tent. The VH in Vinthenga was able to articulate the process of construction as well as the materials used.

I have used a logit regression model to try to understand what factors influenced the fish processors to participate in the project or not. The results of the step 1 analysis (Table 5.7), where participation was the dependent variable, shows that 21 respondents indicated that they are using the dryer. In the participation variable, there are 13 participants and 83 non-participants.

The results show that the location of the fish processors, represented by the village variable in the model, is the only determining factor for participation in solar drying activities, with those in Chipala having a less likelihood of participating. This corresponds with the data from the interviews which shows the differences in commitment to the project, with the community in Chipala showing the least interest in taking part in solar drying activities.

Table 5.7: Logit regression model for determining factors of participation in solar drying activities

	B	S.E.	Sig.	Exp(B)
Age	0.08	0.069	0.25	1.08
Gender(Male)	-0.61	1.243	0.62	0.54
Village(Chipala)	-3.32	1.185	0.01***	0.04
Ethnicity			1	
Ethnicity (1)	16.76	40192.95	1	18990159
Ethnicity (2)	-2.09	44250.63	1	0.12
Ethnicity (3)	38.36	56841.43	0.99	4.58
Ethnicity (4)	-0.40	46000.44	1	0.67
Ethnicity (5)	16.90	40192.95	1	21959568
Ethnicity (6)	0.01	56841.43	1	1.01
Years of education	0.14	0.10	0.18	1.15
Number of children in household	0.21	0.48	0.65	1.24
Household size	-0.09	0.50	0.85	0.91
Constant	-21.02	40192.95	1	0

*** $p < 0.01$

One of the risks of giving incentives to community members is their continued reliance on incentives to participate in community development. This is the case in Chipala, where the participants were more driven by the monetary benefit that they would gain from managing the tent. The same can explain the difference in prices between the two communities, with the cost of using the dryer in Chipala pegged at MK500 per bucket and in Vinthenga MK250 per day regardless of the amount of fish processed. The price in Chipala is far more expensive than for a similar target group in Vinthenga. The BVC members' insistence in the latter that the price does not need to be adjusted is evidence that the dryer is seen more as a moneymaking venture, rather than an improvement to fish processing and thereby improving the livelihood of fish processors. When livelihood strategies are mismatched with the incomes of targeted groups or communities the livelihood outcomes are anything but transformed (DfID, 1999). Furthermore, the introduction of innovative technologies that add value to a product ought to take advantage of already existing commitment to the trade, thereby expanding the market of the produce and improving income (Ngochera *et al*, 2012). Thus, based on the data, the main challenge was participation (and ownership, in the recoded dependent variable), which then affected the level of adoption especially in Chipala, as the logit model also explains.

Capacity building

As part of capacity building, the SEED-Fish project staff explained that the project was also intended to expose the communities in Vinthenga and Chipala to other communities that are also using the solar drying method to appreciate the experiences of other FPs. The closest community from Nkhotakota is in Salima, which is the neighbouring district. Learning visits were, however, not conducted during the project, as these were a component of and dependent on one of the project's student's study.

Asked whether the communities had the capacity to construct the dryer on their own, the project staff expressed that the communities would not be able to construct the tent on their own. This was precisely because, during the project there were no trainings held on construction, facility and economic management. Accordingly, trainings conducted within the project were only for the carpenters who constructed the tent. The communities were only sensitised about the technology and its benefits. The response from the solar drying FGD respondents in Chipala was evident to this fact, as two of them stated,

"we were told that the most needed thing is sunshine. Otherwise what is needed is the maintenance for the fish to dry well." Male participant, solar drying FGD, Chipala

"what happens is that the person who is drying fish in here is the one who knows how long the fish will stay in the dryer." Male participant, solar drying FGD, Chipala

However, the project staff expressed that the community had the capability to finance the construction of a dryer, as a collective. The community included fishers, who made more money than the processors. The challenge is that besides the committee at the tent, there are no collective initiatives in fishery activities.

Exchange visits have been described as one of the most effective tools for increasing adoption of innovative technologies because of the encouragement that participants gain from the experiences and viewpoints of their peers (Matras *et al*, 2013). Without exposure to other successful experiences of using the dryers, mobilising the community to finance and construct a dryer would be difficult. However, even though exchange visits were not conducted, the success in Vinthenga has not motivated the nearby community in Chipala, approximately 300 metres away, to resolve their conflicts and use the dryer. Nevertheless, if conducted, the exchange visits might have increased adoption even though the dryer in Vinthenga cannot cater for all fish processors in the community. Thus, increasing adoption might not have the desired impact and could have even resulted in even less impact. The advantage of exchange visits would only be to build the capacity of the fish processors in how to manage the dryer and possibly increase their profits by establishing links to other markets. The verbatim above also explains that the participants were not entirely sure of how the dryer works and how it can be used for value-addition.

Training and educating communities have been defined as means to widen the capital base and thus enlarging people's choices. The lack of training in the project means that committees and any other leadership involved in the fish processing value chain have not gained technical knowhow about dryers and thereby have limited knowledge about a technology that they are supposed to promote in their communities. Similarly, the limited knowledge that fish processors have, limits their innovativeness to improve the service by tapping into their already existing livelihood assets. Thus, the lack of capacity building here is a hindrance for increased access to and use of solar dryers and thereby limiting transformation of the communities' livelihood assets, and political and social structures.

Value addition

Of the solar dryer users (n 19), 21% sold their solar-dried fish outside of Nkhotakota, whilst 79% sold their fish locally. 21% expressed that the solar drying method had improved their fish processing business. The majority attributed the improvement to better quality fish and profit (75%), whilst others attributed the improvement to less expenses, high demand of solar dried fish, and efficiency during rainy season. The lack of improvement was attributed to the lack of space in the dryer**.**

74% of the solar drying respondents indicated that the solar drying method would still be in use in the next 20 years, with the remaining 26% sceptical of the sustainability of the method (Figure 5.16).

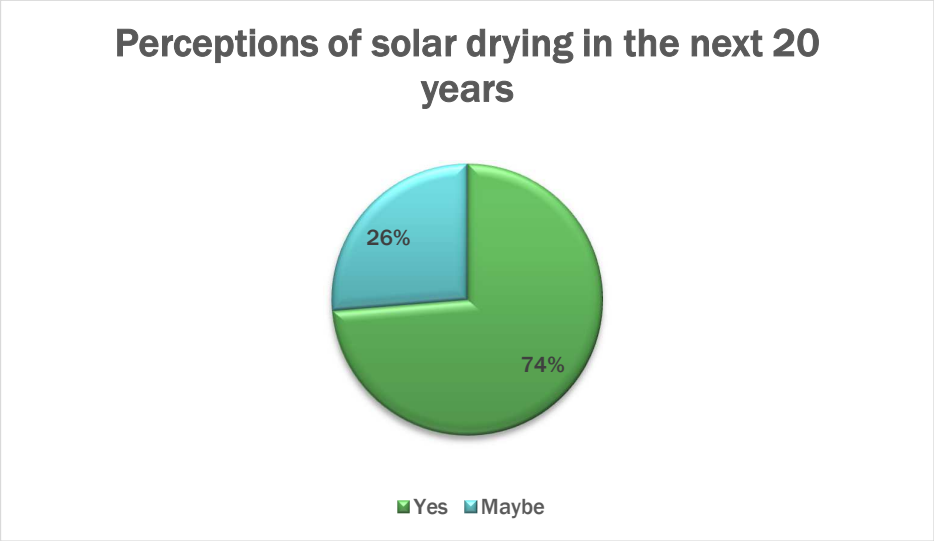

Figure 5.16 Perceptions of solar drying in the next 20 years

The 74% expressed that the solar drying method would still be in use because of the following benefits that they perceived: quality fish, higher profits and time efficiency; good maintenance of the dryer and the willingness of FPs in solar drying activities. Those who were sceptical (marked in the blue colour in Figure 5.17) indicated that the method might not be used in the future because FPs had not been trained to construct and maintain the tents and maintenance of the tent was expensive.

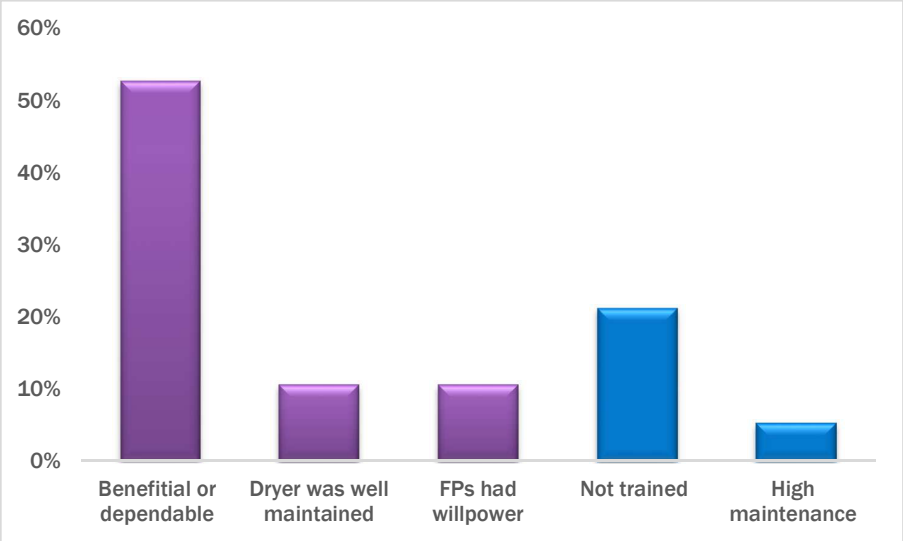

Figure 5.17 Perceived reasons for sustainable use of solar dryers

Ownership

The management of the dryer in Vinthenga revealed communal ownership of the development. As per design of the project, the communities own the solar dryers. The committees are responsible for the maintenance of the tent. The committee treasurer collects money from people who use the tent, and as a result, repairs have been made on the dryer. These funds were also used to replace the plastic sheets on the tent

Monitoring of the sites, especially in Vinthenga was done by the SEED-Fish project staff. The group spent K100,000 to maintain the tent, and this cost covered plastic sheets, wood planks, and nails. After the tent was constructed it was handed over to the BVC, which then handed the tent over to a subcommittee formed at the tent, which consists of fish processors. There is a newly elected BVC which is not taking any part in managing the tent because they were not there when the tent was first constructed.

The committee in Vinthenga, however, was not aware of the cost of constructing the tent. They contributed sand and water on voluntary basis, which were sourced for free from the lake and beach, 15 metres from the dryer. The rest of the materials were purchased by the project. However, the groups had to ferry the materials from the vehicle to the site due to bad road networks within the village.

The majority of the respondents indicated that they could contribute locally available materials and labour (Figure 5.18). Of the solar dryer respondents, 71% thought it was possible for the community to construct the dryer, whereas 29% were not sure it would be possible. Of those in

doubt, there was a 57% response that construction of a dryer was too expensive, whilst 42% thought it was they who did not have the required expertise. Both communities have the advantage of locally available building materials that they have free access to, such as sand and water, as all of the respondents were within 5km distance to the shore (Figure 5.1). Thus the physical capital in the villages is not only beneficial for traditional processing methods, but are also a source for furthering adoption of the technology, if the communities were trained on how to construct the dryer.

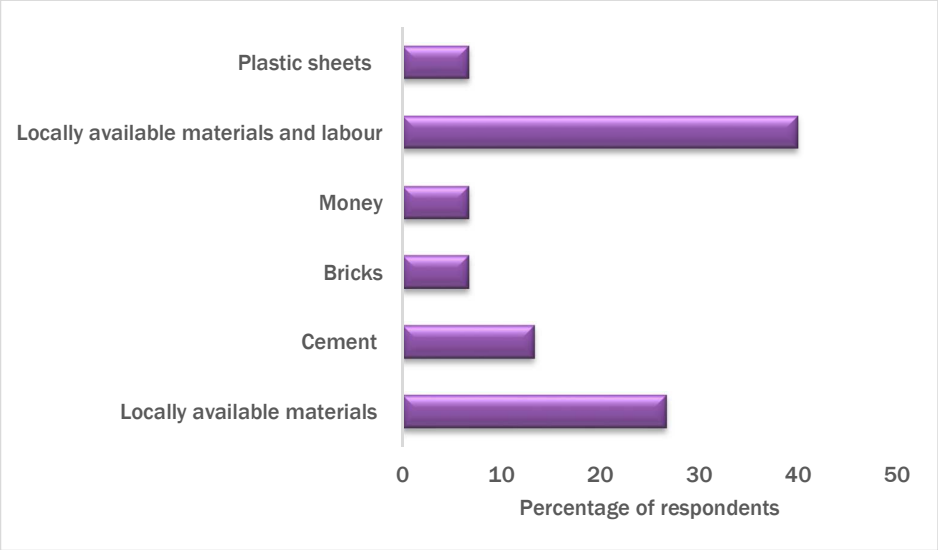

Figure 5.18 Respondents' possible contributions towards dryer construction

The focus groups felt that given all the materials that were used, they did not have the competence and resources to construct another dryer in their village. The SEED-Fish project staff was aware that plastic sheets can be purchased at Arkay plastics, a Malawian company that specialises in plastic products in Blantyre. The project staff were doubtful that the community members would travel to Blantyre to purchase the sheets, because of their socio-economic status. The situation in Chipala was quite the opposite. Even though the tent was not in use, the door was missing from the tent and several plastic sheets were torn. Below is an excerpt from the discussion on the physical condition of the dryer and the role that the BVC has played in managing the tent.

"In terms of taking care of it, we face a challenge in the night. Because in the night you cannot come and guard this place. ***Why not?*** *Eh! (laughter) it is too far.* ***Oh, is it too far from where you are living?*** *No, it is not that far, but for you to leave the house and come here, where you*

won't find anyone else, is different from going to a harbour. ***What if there were two of you?*** *Two people?* ***Yes.*** *We can come around, the only problem is the time you come to go round is not the time that the thieves will come (laughter). And when you've left, that's the time that the thieves will come… But if it were that this thing was at the harbour… there's always people there…In Vinthenga this thing was placed right at the harbour…* ***How did the sheets get damaged?****... it seems to be the sun…* ***who is supposed to replace the sheets?*** *… we asked and they [the project] said that they would come back and fix it…for us to make money and maintain the tent from the same amount… No!* ***Do you know what the cost of constructing the tent was?*** *No, I don't know, we didn't ask (laughter)…"* Various participants, solar tent drying FGD, Chipala.

Contrary to the community in Vinthenga, the BVC members in Chipala expressed a more laid-back approach to their duty of managing the dryer. Perhaps this can be attributed to the fact that the tent is of no use. They expressed that the dryer was not in use because it was too far from the harbour, however the person who once used the dryer did not express distance as an issue. Further, after the FGDs, walking along the beach I discovered that the harbour was in sight from the solar tent dryer (Figure 5.19). Thus, the reason of distance was no longer justified.

Figure 5.19 Picture depicting distance between solar tent dryer and traditional OSD drying racks (marked in red) (Source: Fundi Kayamba-Phiri)

There was a lot of laughter during the discussion which from observation showed the lack of interest in the dryer. This was confirmed by an active member of the BVC who I met on several occasions at the site and had an interview with. Confirming his statements, the only lady who had used the dryer before expressed that the active BVC member was the only person who was eager to use the dryer, whilst it was a collective decision made by the BVC to deny the lady and her group access to the dryer.

The findings correspond with the findings of the Ngochera *et al* (2012) in the Lake Chilwa Basin that co-management between the government and BVCs over natural resources presents conflicting lines of authority between local institutions. The BVC assumed leadership over the technology albeit with limited knowledge about fish processing and marketing. The delegation to a subcommittee (the solar drying committee (SDC) in Vinthenga ensured that experienced fish processors were part of the decision-making processes concerning the dryer, and thus empowering the fish processors to use and advocate for using the solar tent dryer. As seen in Figure 5.1, 15 out of the 19 respondents were using the dryer were members of the SDC. Thus the improvement of social capital in Vinthenga has the potential to yield the expected outcome of improved income, if there were enough tents for the processors in Vinthenga.

Value for money

One of the main problems in the use of the dryer is the lack of space in the dryer, thus fish processors do not consistently use it. It was therefore difficult to assess whether their income has improved since they adopted the solar drying method. Furthermore, it was discovered that the project had not tracked the incomes of the fish processors who were benefiting from the solar dryer. The SEED-Fish project staff stated that the component of tracking the incomes of fish processors was part of the project, although part of this component was a study being conducted by a Masters' student from Mzuzu University. The student was also supposed to facilitate linking the fish processors to markets outside of Nkhotakota. The project ended before these activities were done.

The staff expressed that the fish processors' incomes had improved, but the impact is not as vivid because most of the fish is still traded locally. To assess the impact of the usage of solar dryers on fish processing incomes, I calculated the proportion of income that can be attributed

to selling solar dried fish. As there were two main seasons, the proportions are for peak and off seasons. I have used the following formula to calculate the proportions, where:

P= Proportion of profit attributed to solar tent drying

s = solar tent dried fish selling price

b = buying price

$$P = (\sum s - \Sigma b)/\Sigma s$$

The total sum of the selling price of solar dried fish (peak or off season) less the buying price of the same was the profit. The profit was divided by the sum of the selling price which resulted in 44% of the profit attributed to the usage of solar dryers during the peak season, and 31% during off season. During the peak season the attributed proportion is higher which assumes more frequent usage of the dryer, and the opposite is true for the off season. The data corresponds with the field observations where it was noted that the dryer was empty during the week of data collection. The FGD participants expressed that fish catches were low at the time, and thus proportions during were lower.

The project has documented some experiences with the solar dried fish through a demonstration held at a trade fair in Nkhotakota where they sold a lot of fish. They also had sun dried and smoked fish. Solar dried fish was the most sold on that day, and some people have continued to ask about the fish. For the demonstration, the fish were packaged and branded which also attracted customers.

There are no figures of how many people are currently using the dryer. The committee at the tent were instructed to keep a record, however they were not consistent in this task. The project designed a form which the committee was supposed to use. The committee members did not have the form with them at the time of the interview. The SEED-Fish project staff also stated that it is possible that because the committee member responsible for the records was a fisherman, he was not always available whilst FPs used the tent.

Most materials for constructing solar tent dryers are locally available, except for the plastic sheets that can be bought in Mzuzu or Blantyre. The committee members at Vinthenga also suggested that using old sugar plastic bags could be an alternative to the plastic purchased at Arkay. He was not sure of the shops where the plastic sheets could be purchased and guessed that a shop like Arkay plastics would carry them.

One of the main differences between the committees in the two villages is the fee charged for using the dryer. The charge in Vinthenga was K250 per day regardless of the quantity of fish. The charge for using the dryer in Chipala was set at K500/5kgs, so one of the 2 people who used the dryer in Chipala had to pay K2000 for using the dryer. When asked if they thought the price was too high, the BVC members agreed, though they did not express that this was a problem, as they only cited that most people who process their fish cannot afford to dry their fish in the tent and would rather smoke or fry their fish.

It is worth noting that some of the main activities of the SEED-Fish project were not fulfilled, largely because these activities were dependent on the progress of students under the project. The disadvantage of implementing projects that directly affect livelihoods, combined with research, is the oversight of possible challenges that students might face during the implementation period. In the case of the SEED-Fish project, continuation of the project as planned was doubtful because no estimates of the adjustments in FP incomes due to using the dryers were made. Such an implementation strategy is opposed to that recommended in the sustainable livelihoods approach (SLA) which places the people at the centre, rather than the resources, government or implementers who serve them (UNDP, 1990). The emphasis on research thus overshadowed the impact of using the constructed technologies on the livelihoods of fish processors. A similar case was noticed at community level, where BVC members stated that the price of using the dryer in Chipala was expensive, without expressing any plans to negotiate on the price to increase utility of the dryer. Thus, even at community level the targeted people were not at the centre of implementation.

The SEED-Fish project staff expressed that the dryers were introduced as a means of improving fish processing in a district with the second largest population of fisher folk in the country, but also a place where most of the fish processors only sell their fish locally. The project therefore serving as a means to add value to the fish and assist the fish processors to sell their fish beyond Nkhotakota.

Based on the sustainable livelihood framework (Figure 3.1) one of the processes that transform the vulnerability context of a community, and therefore also their assets, is the existence of policies that foster the improvement and sustainability of renewable resource technologies (DfID, 1999). Whilst other technologies such as improved cooking stoves have gained traction and been included in renewable energy policy, technologies such as fish solar dryers have not been included. However, it is noted that policy development in the Malawian context tends to be a lengthy process, as the renewable energy policy of Malawi was in draft form up until 2016.

The synergy between immanent and intentional development entails that the development efforts of government, with policy formulation and implementation, compliment the development efforts of NGOs and other private institutions (intentional development) (Morse and McNamara, 2013). Whilst communities such as Chipala and Vinthenga may use technologies such as solar dryers without value-addition mechanisms, such developments yield minimal impact. Issues of incentives, such as access to markets outside of the district and exposure might be included in policy to ensure continuation after the project. However, I also note that there is continuation in the Lake Chilwa Basin, where I conducted a pilot focus group discussion. In the Lake Chilwa Basin, continuation can be attributed to project efforts to link FPs to markets and the fact that the community uses the dryer as a collective, which allows them to mobilise more resources to access markets outside their area.

5.4 Adoption of technology versus limited use of fuelled processing methods

Adoption of the solar drying method

There were 19 respondents who indicated using the solar drying method, all of which were from Vinthenga village. The number of fish processors per method are shown in Figure 5.20.

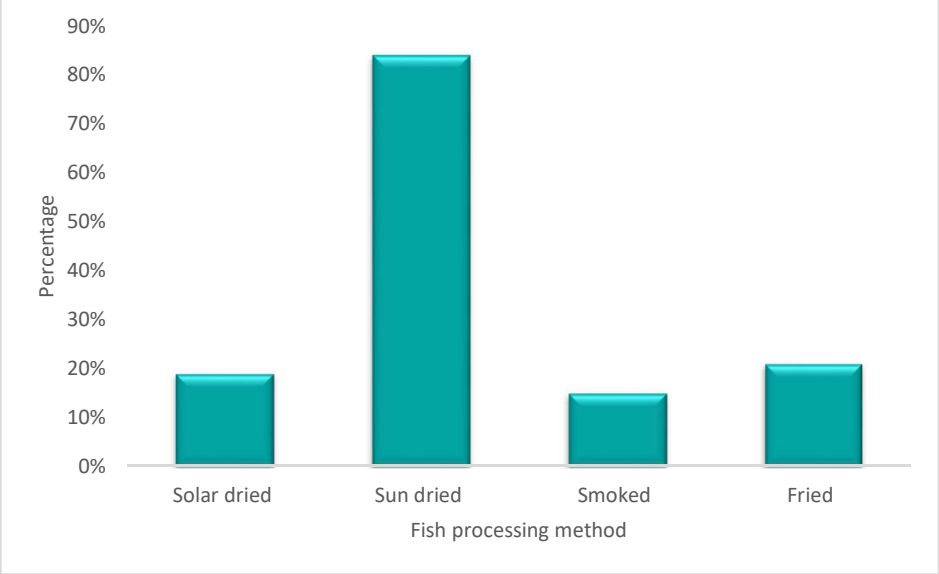

Figure 5.20 Number of fish processors per method

The FGD participants indicated that their reasons for adopting the technology were the possibility of improving the quality of dried fish as well as spending less time processing the fish. None of them indicated using fuelled methods; however, they continued to use the sun drying method after adopting the solar drying method. The reasons for continuing to use the

sun-dried method were lack of space in the tent and customer's preference for sun dried fish (Figure 5.21).

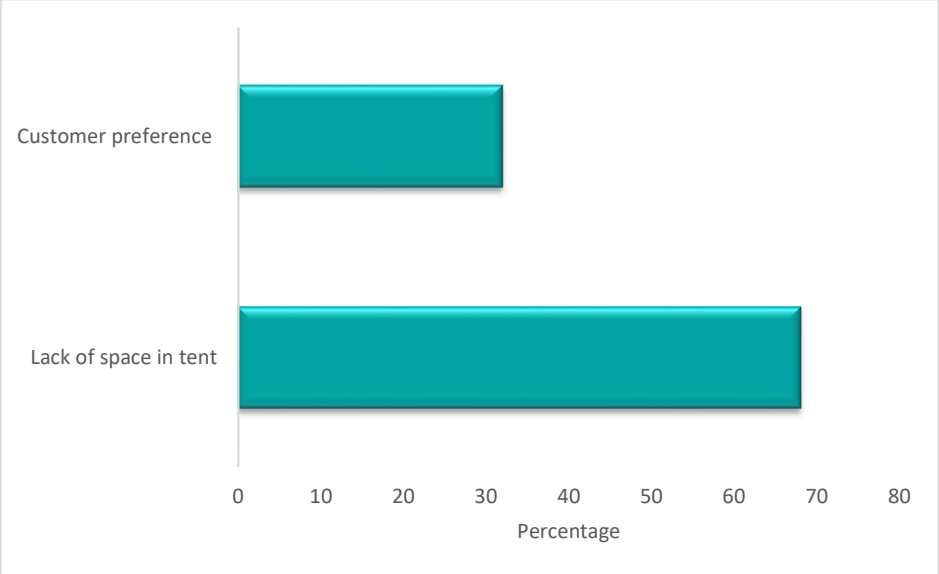

Figure 5.21 Reasons for using other methods after adoption

The respondents adopted the technology between 2016 and 2017 (Figure 5.22), with most adopting in 2016 when the dryer was constructed.

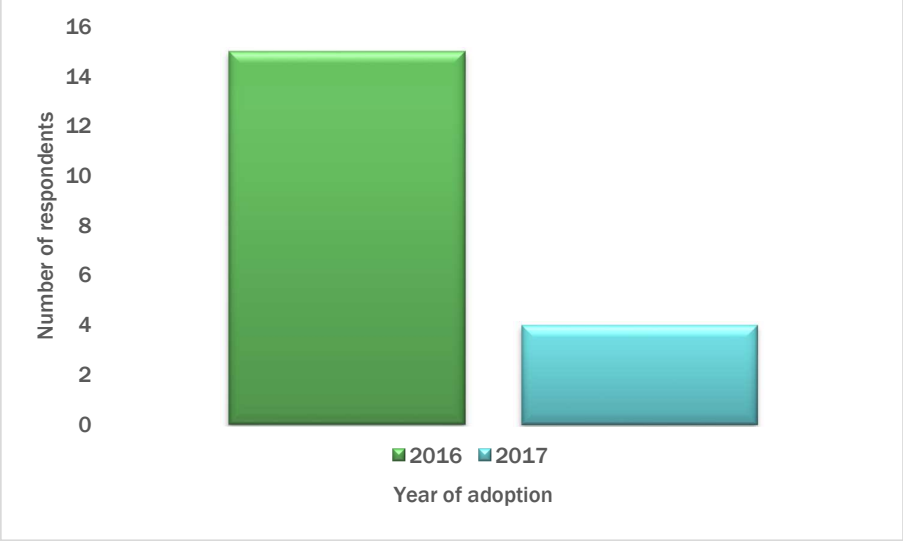

Figure 5.22 Year of adoption in Vinthenga (n,19)

Respondents who did not adopt the method (n, 80) expressed that it was because they had no access to a dryer (35%), were not aware of the technology (26%), lacked capital (5%), preferred fresh fish (3%), were not interested (9%), processed a small amount of fish (5%).

Implementation strategies

The tent dryers were built in phases, the first being at Chipala in 2015 and then Vinthenga in 2016. The SEED-Fish staff explained that the reason for this was that there was no SEED-Fish staff on the ground at the time, so those supervising construction were coming from MZUNI in Mzuzu. The supervision was, however, affected by the pace of the students whose studies were one of the outputs of the project. The project staff indicated that they were not aware of the whole cost for constructing the tent but could only state the price for the foundation, which was K100,000.

In July, 2017 when data was collected, the project staff stated that the community was not aware that the project had phased out. The phase out was only communicated to the project staff by phone. The expectation, however, was that there were plans to have an extension of the project, but this could not materialise as there were not enough funds to extend the project.

The project staff agreed that the siting of the tent in Chipala affected adoption and that the communities had also agreed to have the tent on Department of Fisheries' premises. The communities, however, only started to complain about the siting when they noticed how much of a success the dryer was in Vinthenga.

The staff expressed that construction of a second dryer within Chipala village, by the dock would increase adoption. However, it was expressed that the community in Chipala is mixed with settlers from other parts of the country, is close to the trading centre, whilst people in Vinthenga are all originally from that area, and thus had a unified vision of development in their village. The data show that 14% (n, 54) of the respondents were settlers in Chipala, and only 3% (n, 45) in Vinthenga. For every community involvement, the Chipala community expected to be paid. In hindsight, the alternative would have been to construct both tents in Vinthenga because that would have had greater impact.

In addition, the project staff experienced some challenges that affected execution of duties, especially contact with the fish processors and committees. The terms of employment were therefore not fulfilled, apart from the fact that there had been no office space, no computer and other office materials. There was also no provision for transportation. Normally extension workers are provided with a motorbike but there was none though fuel was provided for.

Consequently, communities were visited on foot and all these challenges have been well documented.

On siting of the dryer in Chipala, the DFO stated that the Fisheries Department was involved, however, it was the research unit that participated in the planning of the project, and not the extension office. The extension office was also not involved in the baseline survey. They were made aware of the team collecting data but were not part of the team. To the knowledge of the DFO, the communities in Nkhotakota gave information to visitors with the view that they would receive something at the end, which could have increased the possibility giving out inaccurate information. This was mentioned because according to the project, the communities agreed on the dryer being constructed on fisheries' premises.

The DFO also stated that communities also became suspicious of teams that were not introduced by extension officers. Having the backing of the Fisheries Department made it easier to interact with the communities because they had built trust with the extension workers. They were only involved following the recommendations in the baseline survey report. The extension office was involved in some FGDs with the communities but plans for the project had already set. Selection of which villages to be included in the project was also done without consulting the extension office. The DFO office's view was that it would not have not recommended Chipala as an impact area for the project. Later the extension office was involved, especially when it came to construction, though it was too late at this stage to influence the siting of the impact area. As expressed below by the solar drying FGD participant in Chipala, the siting has been widely regretted.

"The problem is that this thing [the solar tent] was built too far…. too far (in unison)….because this thing is here [where the FGD took place] and yet people are fishing over there!! (points to the other side of the beach, which can't be seen). So for someone to carry fish from over there and bring it here, that distance is too long for them… they'd find themselves paying money to transport the fish. This one was built for… the Fisheries department… it was built for them [the fisheries department], so it [the tent] is waiting for them to come and use it! (laughter) If they wanted this [the tent] to be used, they would have built it close to that blue gum tree…. they built this for the fisheries department." Solar tent drying method FGD participants, Chipala

Consequentially, statements made in the verbatim above explain the failure to assume ownership of the dryer by the community in Chipala village. The concerns of the participants reiterate the fact that at the centre of creating sustainable livelihood are the targeted people,

rather than resources. Based on the data, the utility of the technologies constructed in Chipala has mainly been for research purposes, rather than improving livelihood, as the community does not use them. Thus, the findings here confirm those from literature that in value addition in fisheries, economic and ecological components are at the centre of governance, whilst side-lining or totally ignoring the socio-cultural domain (Urquhart & Acott, 2013, Reed *et al*., 2013).

Various levels of governance are in conflict here: first, between the extension office and the BVC, second, between the BVC and fish processors. The fact that the choice of the site came from the Fisheries Department, thus using a top-down approach, has caused the BVC and other members of the community to conclude that the dryer was constructed for the Fisheries Department, rather than the community. The findings show that governance, as an interaction between different stakeholders or levels of governance, has been a challenge though, as Johnson (2006) states, governance as a process should reinforce ties between stakeholders. There was lack of harmonisation of the levels of governance, and that was observed in the differences between the two communities, even though they are neighbouring villages. The loop diagram below (Figure 5.23) illustrates how governance has affected livelihood outcomes. The situation in Chipala showed that if the governance structures are not transformed, interventions such as those by the SEED Fish project will not yield the expected outcome, as the community go through a circle of low adoption and thus minimal impact due to poor governance. This was confirmed by the DFO who stated that if asked, the extension office would not have recommended Chipala as a target area, which in itself does not solve the governance problem.

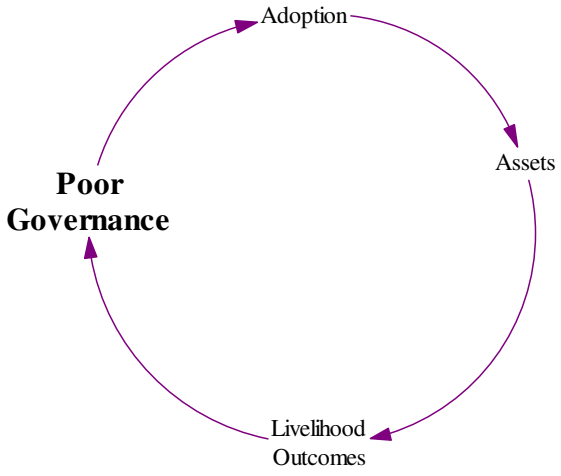

Figure 5.23 Loop diagram illustrating the effect of governance on livelihood outcomes

The implementation strategies in the two sites were different, with the community in Vinthenga having a more active role from the onset of the project, an almost bottom-up approach. The result of their participation was the identification of a site that was most suitable for the fish processors. Furthermore, even if Chipala was established as a research site, the community might have benefited from being part of the research process. There were a few individuals who worked with the students whilst they conducted research at the site, however the research process did not include those targeted to use the technologies. Morse and McNamara (2013) recommend doing research with the community as a partnership approach towards knowledge, as compared to regarding the fish processors as mere recipients of "new" technologies.

Furthermore, whilst the community can appreciate the technology the fact that they cannot appreciate the cost of constructing other dryers makes it difficult for them to evaluate whether they can afford construction. The situation in Chipala and Vinthenga underscores the need for information as a stand-alone capital, as recommended by Odero (2006), as the attachment of information to social capital tends to reduce the visibility and importance of information and knowledge sharing. Ideally such knowledge sharing would then feed into evidence-led policymaking processes at village level.

It was interesting that the project staff also did not have access to information about the cost of the dryers, except for the materials and quantities of the same. The flow of information between the project staff and project implementers elsewhere, as well as the fish processors was strained because of other administrative challenges that were faced. The lack of transportation affected the supervision and access to community members and meetings that could have been used as means to increase adoption or to lobby with leaders in Chipala on the use of the dryer. Thus, the lack of monitoring the project also affected the outcome of the project.

The findings show transformation in the financial capital of the community in Vinthenga where maintenance and overall management of the tent is now financed by the community through the committee. Morse and McNamara (2013) explain financial capital beyond the economics construct of 'money' that can be held in a bank, as also the management of financial resources that results in value addition to an investment such as the dryers.

Implementation strategies have led to conflicts. If conflicts already existed, it would have been noted that the project was not going to be a success in Chipala. As stated by the DFO, that if the project had involved the Fisheries Department on the potential sites, Chipala would not have been one of them. However, the actions of the Fisheries Department, especially the research

unit, affected the selection of a site where expectations of success were already low. The situation suggests the lack of information flow between the two sections within the Fisheries Department. For the fact that the Department was already in a co-management agreement with the BVC, ideally the choice of site by the community itself would have created a sense of ownership and at the same time not hinder the need for the Fisheries Department to use the technologies for research purposes. The community's involvement would have ensured high adoption of the technology, and thus potential actors in research, whereby the fish processors would have provided their services by either processing or assisting in processing the fish required for research, and thereby also serve as extra income. This would have also built the capacity of the fish processors. With their years of experience, their involvement in research in fish processing would have been a possible means for improving the introduced technologies. However, the described model would not have worked as there were no trainings conducted. Thus, the data indicated that the choice of the Department, together with the project, to construct the dryer on the Department's premises directly affected adoption of the technology.

The demand for fresh versus processed fish

The male participant in the FGD at Vinthenga expressed that selling fresh fish would be a suitable alternative to selling solar dried fish. He also stated that the demand for solar dried fish is not vividly high now because of inconsistent use of the dryer. In all the discussions, it was communicated that most people like fresh fish. Access to ice for people to preserve fresh fish is the only barrier. One female participant explained,

"…we only fry the fish if we notice that we cannot sell the fish whilst it is fresh. Sometimes you will notice that the fish is not as fresh to last 2 days so then you opt to fry it to look more appealing. We spice them with curry to make them look more appealing."

"….the problem with fresh fish is that you must buy ice, for like K1000, whilst when the fish is dried it can last longer."

Traditional methods FGD, Chipala

One of the challenges with intentional development is the assumption of the needs of the poor by project implementers (Morse and McNakama, 2013). The findings showed an emphasis on the preference for fresh fish as compared to any processing method. Some participants also

stressed the need for ice making machines instead of improved processing technologies such as the dryer and kilns. However, due to customer preferences there is a demand for processed fish.

5.5 Implications of gender perspectives on the livelihoods of fish processors

Gender perspectives of the fish value chain

Women are the main fish processors in Nkhotakota. The respondents explained that women got involved in fish processing as a business opportunity and therefore income generation. Men are more involved in catching fish. There are more than 150 female fish processors in Chipala and Vinthenga, but the figures of male FPs were not clear amongst the fish processors. The estimates were that there were less than 30 in both villages. The BVCs could not provide actual figures of fish processors in their respective villages. The income sources between men and women were not significant (Table 5.8), be it income from fish processing or other sources.

Table 5.8: Cross-tabulation of income sources by gender (n, 99)

		Gender		Total
		Male	Female	
Number of other income sources	0	5	33	38
	1	7	37	44
	2	4	12	16
	3	1	0	1
Total		17	82	99

P = 0.11

Even though the differences in income by gender was insignificant, the frequencies of the fish processing income and other sources of income are shown in Tables 5.9 and 5.10 to give an overview of the differences within the sample.

Table 5.9 Frequency of fish processing Income by gender

		Gender		Total
		Male	Female	
Fish processing income (MK)	2000 – 10000	0	6	6
	12000 - 30000	3	20	23
	35000 - 60000	4	31	35
	60500 - 100000	6	15	21
	130000-250000	3	9	12
	300000	1	1	2
Total		17	82	99

P= 0.68

The female FPs explained that at times they hire men to help them transport the fish from the boat to the dryer or drying racks, as well as to dry their fish. These men are not their husbands. The participants agreed amongst themselves that the response from their husbands is normally that they cannot spend their time drying fish, or helping their wives doing the same. One man in Chipala explained that,

"Here in our village, most of us [men] *will go to the lake. So, the men normally go fishing and the women are our customers. So that is the women's business."*

Table 5.10: Frequency of income from other source by gender

		Gender		Total
		Male	Female	
Other source income (MK)	500 - 10000	2	16	18
	12000 - 30000	2	15	17
	34000 - 50000	1	6	7
	55000 - 130000	2	3	5
	200000 -300000	3	1	4
	1500000	1	0	1
		11	41	52

P= 0.57

Following these remarks, I asked why women were not involved in catching fish, to which the male participants responded that it was forbidden. The responses to the question why and who forbids women from fishing were interesting:

"They can't go into the water...they cannot manage it…"

"No, but it is also forbidden…"

"We are different [males and females]*"*

"[It is forbidden] by the forefathers, and it is from a long time ago"

[see Appendix 9 for middle section of the discussion]

Our being is also different. ***Mmm.*** *So, it is difficult to work together far out on the lake…far… It just means that that boat will not function properly, and there is no dignity in the way people sit because you'll be facing her.*

And it will be "Oh how are you sitting there?" and that means the journey is disturbed, but also sometimes you take off your clothes out on the lake and remain with your underpants… to

make yourself feel lighter…so would a woman be able to take off her clothes?! (laughter)…You will be ashamed that she will see you naked.

Male participants, solar drying FGD, Chipala

The perspectives of the female participants were similar, however inspired by the general perspective of men about the women's role and limitations in fisheries. The women thoughts are shared in the discussion below:

*"It's a lot of work, and they say we cannot manage to do it…**They say? Who says so?** The men…. **Would you like to try?** No. **I met some female FPs at a lake close to Zomba and they told me about a woman who is a fisher**….eh! what type of fishing does she do? The same as the men, with the big fishing nets…eh!* (surprised) *She is used to it. Because we listen to our husbands when they say, "we went quite far today" and we say we cannot manage. **Why?** It needs men, who are strong. And women are not strong? Those nets are very heavy. What if there was a group of women doing it together? We can pull the nets, but we don't know how, we would need to be taught……..example, at another dock, our friends went to buy fish from the other side of the lake…are these the women who sank? Yes! You heard about this right? Yes….they sank very close to the shore…Oh, it was that close? Yes, close to the Bondo beach* [300 metres walking distance from Chipala]*…but also things happen on the boat and the men sometimes fall off, but because they know how to swim, they survived."*

Understanding the gender perspective of the fish value chain was important to appreciate the different processes and roles that men and women play in the value chain and why. This understanding also gave perspective on how the different actors, men and women are perceived and approached within their roles in the fish value chain. The perceptions of the gender roles in fisheries also gave insight into the intra-household dynamics of gender roles, as the livelihoods of fish processors are influenced by those dynamics.

The verbatim on why women cannot catch fish, for example, gave understanding on the narrative and who holds power of it. The women reiterated what the men had stated, that a woman cannot be a fisher. The women went further to explain why, by stating that they 'listen' to what their husbands share with them about their fishing experiences as something that women cannot achieve. This narrative is well enculturated in the beliefs of both men and women, so much that examples of women who fish are unbelievable or unwelcome. Because recurring instances show the vulnerability of women on the lake, such as women drowning and men surviving, women are reassured that they cannot fish. The data thus corresponds with the

literature that states that the fishing activities that males and females adopt in the fish value chain become their identity (Thompson, 1983).

Gender equality as responsibility shift to women

Men who are fishers will sometimes contribute to the necessities in the household, but most times they will not do so on the basis that the wife is making money from her business to take care of the household. The men will then maybe spend their money on beer. Women decide how to spend the money from their business. The female FPs then talked about how the woman is the homemaker, and that she also makes her marriage. The men are not responsible and often neglect their household duties. From their business the women buy most necessities for the household, even including paying fees for children, and other needs such as school uniform. Thus, as explained:

"When the fish processing business is not going well, then there are serious problems in the household." Female participant, Solar drying FGD, Vinthenga

The discussion about how the income from fish processing is managed within the household quickly turned emotional and the female FPs voiced their frustrations about the household dynamics and how they affect their livelihoods. The women expressed that most women are only married so that they can be known as "so and so's wife". The only man in the group laughed at this but confirmed that what the women were saying was true, and that sometimes when the men make some money they offer their "help". As mentioned earlier, (Section 5.2) saving culture rarely exists in fishing communities. However, the data (Table 5.11) indicated that gender affected participation in three of the four saving methods.

Table 5.11 Cross-tabulations of gender and saving methods

	Gender		Significance
	Male	Female	
Village bank savings	0	18	**
Institutional bank savings	3	3	*
Chihandi savings	2	23	
Personal savings	7	13	**

(Notes: N=99, * and ** show cross-tabulation at significance levels of 0.10 and 0.05, respectively)

The village headman in Vinthenga confirmed the same, also with a laugh, that gender equality is a buzz phrase these days, and thus women are empowered to do business whilst the men then feel that the women can take over their monetary responsibility for the household. The women expressed that this is the general culture in the village, however, they also stated that once they engage in fish processing, theirs should be a contribution towards what the husband already provided. One female FP in Vinthenga expressed this as follows:

"For us business is just to help the man take care of the household, and that's it."

During the FGD with the solar drying group in Chipala, all male, expressed that the profits that FPs make are enough for them to afford the prices that they had set for using the dryer. They expressed that the FPs' profits were high. I brought this up in the other focus groups, which had predominantly female participants and most of them laughed at the fact that the men thought fish processors made big profits. One female FP in Chipala explained it this way:

"Ah people's thoughts….men's thoughts are different, they were responding on their own behalf….a fisherman will bring fish to the harbour worth K30,000, whilst you go and sell the fish and make a loss by selling them at K15,000. For them, they have made money, unlike us FPs. So they know that they are not suffering…they do not know what happens in the market.…we would have to explain to them. But sometimes it is possible to make a good profit, maybe you sell fish worth K20,000 and also make K20,000 on top of that."

The findings correspond with the literature that even though women are involved in all activities post the catching of fish, the women make less money than fishermen, especially those who own the fishing business themselves (Ngochera *et al*, 2012). Despite that the data was skewed as regards gender, the fact that the sample represented half of the fish processing population gave an understanding of the levels of income between men and women. The data showed that there were no male processors with the lowest incomes of between MK 2000 and 19000 (Table 5.7). However, there were 10 women within this bracket. Out of the male FPs in the sample, 4 were within the highest income bracket, between MK 100, 000 to 300, 000 (Table 5.7). Thus, male fish processors have higher income due to more access to capital and mobility, which is limited for women because they typically have more responsibilities within the household once they are successful in their business (Allison and Mvula, 2002).

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

This study examined how the usage of solar dryers had improved the livelihoods of fish processors in Chipala and Vinthenga villages in Nkhotakota, Malawi. Further, the study had four specific objectives. First, the study analysed how the dryers had improved fish processing as compared to traditional methods. Second, the sustainability measures put in place by the project were assessed. Third, adoption and challenges of the same were examined. Finally, the study analysed gender perceptions and roles on how they affect the socio-economic status of fish processor. The main findings for each sub-research question are summarised below.

a. How have solar dryers improved the process of drying fish?

The solar dryers have improved fish processing, and thus there is potential for the method to be adopted if more dryers were constructed, especially in Vinthenga, where the demand to use the dryer is high. However, the impact of the dryers is minimal and not well accounted for. Only one dryer was in use, making the case in Chipala a white elephant project, where the community rejected the development. There was no monitoring of fish processing incomes throughout the period of the project for the project itself to assess whether the technology was yielding the expected livelihood outcome; improved income. Further, the findings indicated that perceptions of the contribution of fish processing to deforestation varied amongst stakeholders. Those involved in fisheries, such as project staff and the fisheries department indicated fish processing as one of the main drivers of deforestation, whilst the forestry officer indicated that the contribution was insignificant as compare to charcoal, timber and firewood (mainly for household use) production. The disparity in the perceptions led to the conclusion that the natural resource management efforts of the two sectors, fisheries and forestry, were not harmonised even though they were interlinked.

The common fish processing methods were open sun drying, frying and smoking. There were no challenges identified with the functioning of the technology. The findings indicated that the quality of processed fish was improved by using the solar drying method, as compared to the open sun drying method. Based on the findings, it was concluded that the solar tent and open sun drying methods were more similar as compared to other methods used in Chipala and Vinthenga because of the inputs needed to process fish, namely drying nets and baskets for ferrying fish to the market.

The solar tent and open sun drying methods required similar materials and depended on heat from the sun, as compared to the frying and smoking methods which were both woodfuel based. The solar tent dryer halved the time normally spent processing fish using the open sun drying method, the latter which took three days. The solar drying methods also reduced contamination of fish during processing due to the covered environment. The better quality of solar dried fish justified higher selling prices as compared to open sun-dried fish. The woodfuel-based methods were the most expensive selling prices; however, this was attributed to inputs such as firewood and cooking oil. Thus, using the dryer, with the least cost of inputs, ensured less shortages, as compared to woodfuel based methods with high input costs. FPs incurred higher profit losses due to fluctuation of fish prices set by fishermen when fish catches are low. Using the solar dryer improved the incomes of fish processors; and 41% of income was attributed to the solar drying method per unit (5kg bucket) during peak season, and 31% during off season.

The challenges concerned the experiences of the fish processors in usage and sales. The findings indicated that the fish processors in the sample were limited to access the dryer because the dryer was too small. The maximum capacity of the dryer was 100kgs, which at times would mean only 5-7 people could use the dryer per processing period.

b. What measures were put in place to ensure sustainable usage of solar dryers?

There were sustainability measures put in place by the project, however, the lack of key sustainability measures poses a threat to the continued use of the method. The lack of any trainings, whether on how the technology works or how to construct dryers to increase usage, meant that the communities had been empowered to manage a technology that they do not entirely understand, let alone know how to replicate.

In Chipala the abandonment of the dryer as well as the conflicts surrounding meant that unless governance structures are transformed the method would not be sustainable as the community has rejected the project, even though they have been exposed to the benefits through the success story of Vinthenga, 300 metres away from them. The logit regression model was used to determine which factors would increase participation in solar drying activities. Only location (resident village) of a fish processor was significant in the logit regression model as a determining factor for participating in solar drying activities, which affected Chipala

negatively. The results confirmed the situation in Chipala which was distinctively different from the success in Vinthenga. The solar dryer in Chipala was mainly used for research by project students, rather than the community. It is argued in this study that the involvement of the wider community in research would have raised awareness of the community as well as build their capacity by contributing with their years of experience.

The formation of a solar dryer committee in Vinthenga resulted in maintenance of the dryer from rental proceeds, which showed the assumption of ownership by the community. This finding indicated that the community had understood their role of managing the tent with no expectations from the project, unlike the community in Vinthenga which expected that the project assist them to manage the dryer, which was dilapidating at the time of data collection. Besides the dryers being handed over to the respective communities, there was no clear exit strategy of the project which had ended a month before data collection. This meant that the situation in Chipala had not been addressed by the project.

c. How many fish processors have adopted the solar drying method and, as result, how many have moved away from wood-fuelled processing methods?

The figures were not clear from the committee in Vinthenga as to how many people had adopted the method. However, the chairperson estimated that at least 35 fish processors were using the dryer, of which 19 were included in the sample for this study. An assessment on how many FPs had moved away from wood-fuelled processing methods was not done because there were no fish processors smoking or frying fish in Vinthenga. However, the solar drying method and wood-fuelled methods were not correlated, and the demand for smoked and fried fish was based on taste and smell. Thus the technologies to reduce the effect of wood-fuelled methods on deforestation was restricted to the use of the improved kilns installed by the project in Chipala. However, the community were not using the kilns either. Thus, there was no impact of the project on limiting deforestation as per the project's objectives.

The main reason for adopting the technology was the quality of fish produced in the tent, as there was a need for a more hygienic and profitable processing method other than sun-dried. Adoption increased as the FPs realised that the method reduced their time spent and activity whilst processing fish. However, the capacity of the dryer in Vinthenga has meant that increases

in adoption limit the impact of the dryer on income, as fish processors cannot use the dryer consistently because of the demand.

Adoption was directly affected by poor governance; a top-down approach employed by both the project to the community, as well as the BVC to the rest of the community. The rejection of the project was a result of a consultative process with community members, the BVC, most of which were not fish processors and thus did not understand the implications of constructing the dryer away from the usual fish processing site. At the same time, the control of the dryer assumed by the BVC has limited those interested in using the dryer. One of the reasons to explain this is the BVC's lack of interest to resolve issues between the BVC and the community, for the intended users to have access to the dryer. Instead, the BVC's solution to the usage of the dryer is to rent it to semi-commercial fishers who use the trolling fishing method. Although the co-management model is intended to empower communities to manage resources within their areas, traces of a top-down approach were visible, which indicated the need for the role of different stakeholders in CBNRM to be made clear, to build sustainable livelihoods.

d. How do gender roles and perceptions affect the socio-economic status of fish processors?

Women were involved in all activities in the fisheries value chain except for catching fish, which is restricted to men. The study found that myths, masculinity attached to catching fish and culture were reasons that affected the reason why women could not fish. Unlike in the neighbouring district, Nkhata Bay, there was no indication that women fish even for household consumption. The reasons why women could not fish were crucial to understand not only the perceptions of the women's role in the fish value chain, but to understand how both men and women understood the capabilities of women. The response to this question indicated that both men and women felt that women were not capable of fishing, which was an idea mainly influenced by the narrative of the men. Fish processing is affected by the fact that women cannot fish because they have no power over the prices set by fishermen, that cause them to make losses, especially in the off-peak seasons. As the women are involved in the rest of the value chain, they have a better understanding of the fish value chain than the men. Post-harvest losses are partly because the fish does not sell in the market because of the high price. The study concluded that, all factors constant, the current fish value chain meant that even with the solar

drying method, post-harvest losses during the off-peak seasons would prevail due to the fluctuation of prices set by fishers with little knowledge of the market.

The gender roles and perceptions affected the socio-economic status of fish processors, in that gender equality was contextualised as a responsibility shift to women who were involved in fish processing and other enterprise. As the majority of the fish processors in both villages were women, the expected outcome of using the solar dryers was limited by the fact that the more profit the women made, the more responsibilities they had. When women engaged in fish processing the onus was solely on them to provide food for the household, school fees and uniform for the children, and other household needs. Thus, without addressing or transforming the exploitative gender perceptions, the socio-cultural aspect of vulnerability will continue to limit how women can benefit from the solar drying methods, without having adequate funds to grow their businesses.

All things considered, the solar tent dryers have had insignificant impact on the livelihoods of fish processors. The solar drying method was adopted in one village and rejected in the other. However, even though the method was adopted in Vinthenga, fish processors cannot consistently use the dryer due to lack of space in the dryer. As compared to Chipala, Vinthenga was a success story. However, the communities were not given adequate information and there were no trainings on how the technology works or how more tents can be constructed to ease pressure on the one constructed by the community. The lack of information has also led the community to assume that they would not be able to construct a tent dryer, as the assumption is they could not afford it, however, the project and projects in other districts in Malawi maintain that with locally available materials the communities have the can afford to construct more tents. Poor governance affected the adoption of the project, and thus large sums of money have resulted in minimal impact in the case of Chipala. The project would have benefited from an interdisciplinary approach, where fish processors were the centre of the intervention, to ensure that the result was sustainable livelihoods.

6.2 Recommendations

Improvements to existing systems and methods are a development challenge, that nevertheless affect efforts to improve livelihoods. As described in the SLA, and reiterated throughout this study, at the centre of interventions such as the introduction of solar dryers should be people, especially the poor. The effects of interventions or projects that fail is the attempt to improve

livelihoods, however, at times causing complications that result in insignificant impact. Thus, the study recommends the following to policy-makers and prospect project institutions:

i. As the solar drying method has been deemed as profitable in all targeted districts, the expansion into further districts would benefit from best lessons from other projects to avoid trial implementation strategies that might leave communities more vulnerable. The context of fishing communities differs across the country, and thus the involvement of different stakeholders, especially those directly affected by the project would ensure a sustainable structure that would empower fish processors to assume ownership and successful management of resources such as solar dryers.

ii. The study suggests that redefining the roles of different stakeholders in co-management systems would result in more participation of local structures in projects. However, as indicated in the findings, co-management agreements explicitly define the roles of different stakeholders, however the system would benefit from more interaction between local institutions such as the BVC, and the fisheries department. Having strict consequences of violating the terms of co-management would empower involved parties to resist from the onset of the project if the terms of the project are top-down.

The study suggests an in-depth study of the governance structures in Chipala and Vinthenga as an area for future research that would make future interventions yield better results in these villages.

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APPENDICES

Appendix 1:

FGD guide for fish processors using traditional processing methods, and those using solar dryers in Chipala and Vinthenga villages in Nkhotakota district, Malawi

A. Start: Characterization of traditional fish processors

In your community are men or women the main fish processors? How many (%) in your community are occupied with fish processing by gender?

If mainly women.. Do women control the income from fish processing? Do they participate in other activities in the fishvalue chain? Who is in charge of selling the fish?

Who is considered as rich? What assets do they possess?

Who is considered as poor? What assets don't they possess?

In which category do traditional fish processors fall under?

Among the fish processors in your community how many are using traditional methods and how many solar?

Can the traditional dryers and solar dryers be characterized in the same way. If not.. what is the difference?

Do they have other occupation/ income than from other than fish for their livelihoods ? Which?

B. Description of the traditional fish value chain (target traditional fish processors)

C. Description of the value chain using solar dryers (target fish processors using solar dryers)

1. What do you do with fish from the time you have bought fish from the fishermen to the time they are ready to be sold?

Probe: What preparatory stages do you go through before you purchase fish?

Who does what by gender?

At what time of the year do you process fish?

What materials do you need?

How long after catching fish does fish processing take place?

How much fish do you process?

What happens after you have processed the fish? Where do you take the fish? How do you know where to take the fish? How much time do you spend transporting and selling the fish?

2. What is your profit from fish processing?

Probe: Is there a ready market?

Do you have to look for markets to sell? Do you sell fish individually or as a group?

Where do you sell the fish? Who buys?

How long does it take to sell all fish?

How much do you buy fish at?

What is the cost for preparing for fish processing?

What is the cost of the whole process?

How much is the cost of a return trip transporting the fish?

What do you go through after you have processed the fish?

Probe: How long does it take to process the fish?

Where do you find accommodation and how much do you spend?

D. Opportunities and challenges for the use of solar dryers

3. What are the opportunities for using solar dryers?

How has the introduction of solar dryers changed the fish processing? What are the main advantage of using solar dryers?

Probe: Do you think the solar drying method will still be used in 20 years from now? If yes why. If no: Why not?

What are the challenges with using solar dryers?

E Fish processing and deforestation

4. How much do you think fuelled fish processing methods contribute to deforestation in Nkhotakota?

Do you think solar drying limits deforestation? How? How much?

Probe: What other causes of deforestation are there in Nkhotakota?

Of these, which ones are prominent and what is the cause?

Appendix 2:

SEED Fish Interview Guide

1. When were the solar dryers introduced in Nkhotakota?
2. Why were solar dryers introduced in Nkhotakota?

Probe: Is there a growing demand for solar dried fish? Are you tracking the income of FPs since they started using the solar dryers? Are FPs making more income?

Was the solar dryer in Nkhotakota replicated from dryers elsewhere or customised for Nkhotakota?

Have you experienced or documented change in fish processing since the introduction of solar dryers?

Are more FPs attracted to solar drying?

3. What is the situation concerning illegal fishing in Nkhotakota?

Probe: Is solar drying taking place outside of the fishing season?

4. What is the demand for solar dried fish in Nkhotakota?

Probe: Have solar dried fish spread outside of the community and Nkhotakota?

What is the preferred drying method in Chipala and Vinthenga? Why?

5. How were the solar dryers constructed and how much did they cost?

Probe: What contributions were made to the construction of the solar dryers by the community?

Can communities afford to construct solar dryers without help from the project? Why or why not?

Who owns the solar dryers, and who are responsible for the repair and maintenance?

Where can the equipment and spare parts be bought?

6. What sustainability measures have been put in place?

Probe: Have you trained communities on construction and maintenance of solar dryers?

What collaboration exists between the project and the Fisheries and Forestry departments in Nkhotakota at district level? and national level?

Is there any collaboration between BVCs and VNRMCs? What kind?

Is SEED Fish involved in any advocacy for renewable energy and low carbon technologies in Fisheries policy? At village level? district level? and at national level?

What provisions are made in fisheries policies for renewable energy for processing fish?

How has limiting deforestation been addressed in fisheries policies? What strategies do you think are best for limiting deforestation in Nkhotakota?

Are there incentives for those using solar dryers? or improved kilns?

Do fish processors adhere to the seasons?

What is the exit strategy for the project?

Appendix 3:

Fisheries Interview Guide

1. When were the solar dryers introduced in Nkhotakota?
2. Why were solar dryers introduced in Nkhotakota?

Probe: Is there a growing demand for solar dried fish? Are you tracking the income of FPs since they started using the solar dryers? Are FPs making more income?

3. Can you describe the response to the solar drying method project in Chipala and Vinthenga?

Probe: Have solar dried fish spread outside of the community and Nkhotakota?

What is the demand for solar dried fish outside Nkhotakota?

What is the preferred drying method? Why?

4. What sustainability measures for the project are you aware of?

Probe: What contributions were made to the construction of the solar dryers?

Can communities afford to construct solar dryers without help from the project? Why or why not?

Have you experienced or documented change in fish processing since the introduction of solar dryers?

What training have you received on solar drying?

What collaboration is there between BVCs and VNRMCs?

What provisions are made in fisheries policies for renewable energy for processing fish?

What collaboration exists between the Fisheries and Forestry departments in Nkhotakota and at national level?

How has limiting deforestation been addressed in fisheries policies?

Are there incentives for those adopting renewable energy or low carbon technologies for processing fish?

5. When are the fishing seasons?

Probe: What is the situation concerning illegal fishing in Nkhotakota?

Is solar drying taking place outside of the fishing season?

What is the logic behind the fishing seasons? Why the specific number of months or weeks?

How is policing of regulations carried out? Do fishers and or processors adhere to the seasons?

Appendix 4:

Forestry Interview Guide

1. When were the solar dryers introduced in Nkhotakota?
2. Can you describe the response to the solar drying method project in Chipala and Vinthenga?

Probe: Have solar dried fish spread outside of the community and Nkhotakota?

What is the demand for solar dried fish outside Nkhotakota?

What is the preferred drying method? Why?

Have you experienced or documented change in fish processing since the introduction of solar dryers?

3. What sustainability measures for the project are you aware of?

Probe: Have you experienced or documented change in fish processing since the introduction of solar dryers?

What information have you received on solar drying?

What collaboration exists between the Fisheries and Forestry departments in Nkhotakota and at district level? And at national level?

What collaboration is there between BVCs and VNRMCs?

What provisions are made in fisheries policies for renewable energy for processing fish?

How has limiting deforestation been addressed in fisheries policies?

Are there incentives for those using solar dryers?

4. When are the fishing seasons?

Probe: Are there activities initiated by the Forestry department among fisher folk during the fishing seasons?

How is policing of regulations carried out? Do fish processors adhere to the regulations on cutting down trees?

Do you think the solar drying method will still be used in 20 years from now?

5. What are the causes of deforestation in Nkhotakota?

Probe: Of these, which ones are prominent?

What estimated have you made of the solar drying method limiting deforestation?

How much do fuelled fish processing methods contribute to deforestation in Nkhotakota?

Appendix 5:

Survey Questionnaire

Permanent link to survey questionnaire:

https://goo.gl/forms/8kZJ2gM2PQqG9xhX2

Appendix 6: Diversification of income sources

Simpson's Diversity Index Number of income sources (N)					
4	12	19182	194	98.88	-97.88
2	2				
2	2				
2	2				
0	0				
3	6				
2	2				
0	0				
2	2				
0	0				
0	0				
1	0				
0	0				
0	0				
3	6				
0	0				
0	0				

2	2
0	0
2	2
2	2
0	0
2	2
2	2
2	2
0	0
2	2
2	2
0	0
0	0
2	2
3	6
0	0
2	2
0	0
3	6
2	2
2	2
0	0
2	2
0	0
2	2
0	0
2	2
2	2
2	2
2	2
2	2
2	2
0	0
2	2
3	6
2	2
2	2
3	6
2	2
3	6
3	6
0	0
2	2
2	2
0	0
0	0
3	6
2	2

0	0			
0	0			
0	0			
3	6			
2	2			
0	0			
2	2			
0	0			
3	6			
3	6			
0	0			
0	0			
3	6			
0	0			
0	0			
2	2			
0	0			
2	2			
2	2			
2	2			
2	2			
3	6			
2	2			
3	6			
0	0			
0	0			
3	6			
2	2			
0	0			
0	0			
0	0			
0	0			
2	2			
2	2			
139	194	19182	0.010114	0.989886

Appendix 7: Income: Other sources of income vs fish processing

Other sources	Fish Processing Income	Total Income	% Other sources	% FP Income
30000	75000	105000	29%	71%
	50000	50000	0%	100%
	100000	100000	0%	100%
300000	100000	400000	75%	25%
	140000	140000	0%	100%

80000	250000	330000	24%	76%
3000	300000	303000	1%	99%
	35000	35000	0%	100%
20000	130000	150000	13%	87%
	70000	70000	0%	100%
	55000	55000	0%	100%
200000	200000	400000	50%	50%
	200000	200000	0%	100%
	50000	50000	0%	100%
1500000	25000	1525000	98%	2%
	15000	15000	0%	100%
	90000	90000	0%	100%
6000	50000	56000	11%	89%
	60000	60000	0%	100%
2000	80000	82000	2%	98%
50000	200000	250000	20%	80%
	20000	20000	0%	100%
	50000	50000	0%	100%
3000	50000	53000	6%	94%
10000	90000	100000	10%	90%
	60000	60000	0%	100%
600	12000	12600	5%	95%
20000	70000	90000	22%	78%
	300000	300000	0%	100%
	80000	80000	0%	100%
500	2000	2500	20%	80%
20000	76000	96000	21%	79%
	80000	80000	0%	100%
	20000	20000	0%	100%
20000	10000	30000	67%	33%
10000	250000	260000	4%	96%
	100000	100000	0%	100%
50000	150000	200000	25%	75%
	50000	50000	0%	100%
30000	60000	90000	33%	67%
	150000	150000	0%	100%
	50000	50000	0%	100%
	20000	20000	0%	100%
55000	100000	155000	35%	65%
130000	60000	190000	68%	32%
50000	15000	65000	77%	23%
	20000	20000	0%	100%
20000	8000	28000	71%	29%
300000	100000	400000	75%	25%
	80000	80000	0%	100%
10000	20000	30000	33%	67%
30000	80000	110000	27%	73%
10000	40000	50000	20%	80%

40000	56000	96000	42%	58%
6000	20000	26000	23%	77%
2000	3000	5000	40%	60%
34000	250000	284000	12%	88%
2000	60500	62500	3%	97%
	25000	25000	0%	100%
800	15000	15800	5%	95%
	25000	25000	0%	100%
	35000	35000	0%	100%
	40000	40000	0%	100%
4000	35000	39000	10%	90%
20000	66000	86000	23%	77%
	45000	45000	0%	100%
	35000	35000	0%	100%
	10000	10000	0%	100%
5000	30000	35000	14%	86%
	30000	30000	0%	100%
	40000	40000	0%	100%
2000	70000	72000	3%	97%
	5000	5000	0%	100%
	45000	45000	0%	100%
20000	40000	60000	33%	67%
	45000	45000	0%	100%
	40000	40000	0%	100%
250000	68000	318000	79%	21%
	45000	45000	0%	100%
	35000	35000	0%	100%
3000	150000	153000	2%	98%
	54000	54000	0%	100%
35000	45000	80000	44%	56%
13000	30000	43000	30%	70%
20000	30000	50000	40%	60%
20000	20000	40000	50%	50%
60000	35000	95000	63%	37%
30000	40000	70000	43%	57%
50000	45000	95000	53%	47%
	40000	40000	0%	100%
	30000	30000	0%	100%
20000	25000	45000	44%	56%
12000	25000	37000	32%	68%
	25000	25000	0%	100%
	25000	25000	0%	100%
	40000	40000	0%	100%
	45000	45000	0%	100%
60000	130000	190000	32%	68%
25000	70000	95000	26%	74%
3693900	6665500	10359400	36%	64%
			Mean	**83%**

	Min	**100%**
	Max	**2%**

Appendix 8

	PEAK SELLING	OFF SELLING	PEAK BUYING	OFF BUYING	PEAK PROFIT	OFF PROFIT	INPUT COST	PEAK PROFIT	OFF PROFIT
Sun dried	3952.38	5625	2743.43	4272.73	603.4	746.72	605.55	15%	13%
Smoked	5333.33	7133.33	2743.43	4272.73	1084.35	1355.05	1505.55	20%	19%
Fried	6960	8535	2743.43	4272.73	1711.02	1756.72	2505.55	25%	21%
Solar dried	4183.33	5500	2743.43	4272.73	834.35	621.72	605.55	20%	11%

Note: Buying and selling prices were based on the means for each variable

Appendix 9

Verbatim from solar tent drying FGD in Chipala

"We do different things…the difference is that a man is very courageous…while a woman, if something were to happen, will not be courageous. It has also happened recently, when women went across to buy fish …they [the women] *had no courage. Because all the men in there survived…because if the boat is sinking and you shout "eh! I'm dying!" ah then you're already dead!"*

….it is possible for a woman to have her own company [business] and own boats, engines nets, but that those who do the work are men, they [the women] are just supervisor. But they never get on the boat? To go where? Where will they go? (laughter)."