Graduate School of Development Studies

Determinants of Fish Catch Levels in Artisanal Fishing in Eritrea

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"………there is little doubt that the problems facing artisanal fishermen in developing countries are among the most intractable ones in the field of development assistance……….."

Francis T. Christy (1986:121)

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List of Acronyms

ANOVA	Analysis of Variance
ECD	Economics of Development
EEZ	Exclusive Economic Zone
FAO	Food and Agricultural Organization of the United State
FDP	Fishery Development Project
FGD	Focused Group Discussion
HP	Horse Power
IFAD	International Fund for Agricultural Development
ISS	Institute of Social Studies
KII	Key Informants Interviews
MMR	Ministry of Marine Resources
MSY	Maximum Sustainable Yield
MT	Metric Tonne
NFC	National Fisheries Corporation
PP	Primary Productivity
OLS	Ordinary Least Square
VIF	Variance Inflating Factor

Abstract

Even though the estimated maximum sustainable yield of the Eritrean Red Sea water ranging from 40,000 – 80,500MT, actual fish catch level was only rarely exceeding 10,000MT. Expert in the area suggest a tenfold increase of the current production or a potential increase at least to the lower bound of the MSY is indispensable. Noting this gap, the study has attempted to investigate the determinants of fish catch levels in Eritrean artisanal fishery using cross-sectional household survey and qualitative data. Analysis of descriptive statistics, bi-variate, multivariate regression and the probit model were used to analyze the data. According to the results of the study, it was found out that the boat type, crew size, fishing experience, access to ice, and fisher's household size were factors that significantly impacted and helped increase the catch levels. In contrast, access to credit facilities, non-fishing income and age of the fisher were found to be linked to reduced catch levels. The study also confirms that the available means of boat propulsion highly and significantly explicated fish catch, and consequently, in-board motorized engine fisheries catch more fish irrespective of the capture technology they employed. We also found that the type of boat is the most important factors in fishery production function. Subsequently, the study is indicative of the relevance of adoption and use of inboard engine fishery to boost scanty artisanal production.

Consequently, a probit model was employed to pin down the determinants of adoption and use of inboard engine fishing technology. The results suggest, access to credit facilities, cooperative membership and operational costs were found to change the likelihood of adoption and use of better technology. Apparently loan facility and cooperatives societies were not efficient in enhancing the production capacity rather only obliging fishers to acquire better fishing vessels. Thus, it seems that alternative usages of these boats and operational credit are negatively affecting the artisanal fish production. In addition to the importance of adoption and use of inboard motorized fishing technologies, our paper is also indicative to direct and encourage the youth to engage in the sector, suggest efficient loan schemes based on clear understanding of the socio-economic conditions and better organized cooperatives to enhance current catch levels that maintains a higher yearly potential yield.

Relevance to Development Studies

Unlike many previous studies conducted, this study lent special attention to the use of quantitative data through incorporating qualitative aspect of the data. Various studies designated the use of qualitative data to investigate constraints of artisanal fisheries production more generally as opposed to quantitative and specific analysis in developing countries. The study fills the gap of little evidence in identifying the determinants of artisanal fish catch using various data analytical tools. It also points out the link between mechanization of better fishing boats on fish catch level as well as on its adoption and use among the artisanal fishers. Hence, it adds an alternative source of evidence in understanding the relationship of artisanal fishery development and its determinants/constraints, which is one of the most intractable challenges in developing countries.

Keywords

Artisanal Fisheries, Eritrea, OLS, Probit, Catch levels, Adoption and use of fishing technology.

Chapter 1

INTRODUCTION

1.1 Introduction

Finding appropriate instruments that may enhance fish catch levels is the most serious challenge for artisanal fisheries. A number of fishery articles written on this subject matter to explore the problem and development issues and strategies pay most attention to qualitative data to explain the inherent problem associated with artisanal fishery sector (Lawson 1984, Sowman 2005). Owing to the general scarcity of socio-economic data on artisanal fishery, research based on quantifiable information is very limited (Diegues 2006, Farrugio et al. 1993). The data collection challenge is prominent in developing countries where the artisanal fisheries are extended over a relatively large but geographically quite dispersed community along the coastal lines (Diegues 2006). This study has therefore attempted to find out the factors that are responsible for determinants of fish catch levels in Eritrean artisanal fishery.

Morgan (2006) stated that due to the scarcity of financial and technical resources, no exhaustive fisheries potential stock assessment has been done recently. Most of the stock assessment has been undertaken during 1950s – 1980s with an estimation of Maximum Sustainable Yield (MSY) ranging from 40,000 – 80,500MT[1] (table 3.2). However, in the past two decades the annual production of the fisheries has been less than 10% of the higher bound MSY estimate and rarely exceeded 10,000MT per year (Tsehaye 2007). The average annual fish catch over the period of 1993 – 2008 was around 6,000MT (figure 3.1, Pasience 2009). Out of this, the artisanal fishery contributed only around 17%, while the remaining was harvested by the industrial fishery sector[2]. The 2010 annual fish catch was not also different, which is 10,000MT and to which the artisanal sector contributed only about 1,000MT (KII 2011, personal interview[3]).

Evidently, the current performance of the Eritrean artisanal fisheries, therefore, is not satisfactory. Preliminary studies to identify constraints impeding the development of the artisanal fishery have been done (Mahmud 2008, MMR[4] 2007, Pasience 2009). However, rigorous researches that combine both qualitative and quantitative data have not been conducted. This study is therefore expected to contribute by filling the existing gap using quantifiable household baseline survey. Owing to the fact that majority of the fishermen are artisanal fishers and are living along the coastal areas in which they face and

[1] Metric Tonnes.
[2] See figure 2.1 for different level of fishery classification.
[3] Personal telephone interview with Key Informant Interview (KII) on the performance of artisanal fisheries, The Hague, July 2011.
[4] Ministry of Marine Resources

experience multifarious challenges, emphasis is given to the sector than its counterpart, industrial fishing. Further, despite the small contribution of these fisheries in terms of global fish production, the sector could offer vital support to artisanal fisheries in providing potential food as well as livelihood (Head 1987, Salih 1998).

This study mainly used cross-sectional data from Fishery Development Project (FDP) baseline household survey collected using the two-stage stratified cluster sampling in Eritrean artisanal fishery. Furthermore, qualitative data from both primary and secondary data sources was employed. These data sources have been triangulated with a combination of various analytical tools - descriptive statistics, bi-variate analysis, multivariate regression, and the probit model.

The result showed that the type of boat, fishing experience, crew size, access to ice, and household size were positively and significantly related to catch levels. In contrast, access to credit facilities, non-fishing income and fisher's age significantly linked to reduced catch levels. In addition to the situational exploration of the characteristics of artisanal fisheries, the estimation of standardized regression coefficient showed the type of fishing boat is the most important variable in the fishery production function. This implies that enhancing fish production required the adoption and use of inboard motorized fisheries against the less resourceful and relatively traditional outboard engine boats among artisanal fisherfolks. Consequently, a probit model employed to pin down the likelihood relation between adoption and use of inboard motorized fishing technology and fisher's characteristics, household resource endowment, and technology characteristics. The result suggested, access to credit facilities, cooperative membership and operational costs were found to put influence over the artisanal fishers towards the adoption and use of better fishing technology.

1.2 Statement of the Problem and Justification

Despite the huge potential of the resource, so far the development of the artisanal fishery has not shown noteworthy improvement. Apart from having enormous potential, the Eritrean Exclusive Economic Zone (EEZ) is also favourable and conducive for artisanal fishing when compared to industrial fishing. This is simply due to the extensive coral reef grounds around the 356 islands and the extended coastal areas (Pasience 2009). Consequently, the livelihoods of the coastal villages are typically the nature of artisanal fishery. The under-exploitation of these resources, therefore, could potentially increase the yearly catch from the few thousand at least to the lower bound of MSY estimate (MMR 2007, Capitaleritrea 2010). Similarly, Tsehaye (2007) argued, to attain MSY fishing rate, a tenfold increase is required from the artisanal fisheries.

The need for the development of artisanal fishery can be accounted to several factors, to mention some. First, it is argued by Alverson et al. and Hall et al. (as cited in Defeo and Castilla 2005:267) "Industrial fisheries have been shown to be wasteful and environmentally harmful, not only by the removal of biomass and diversity, but also by the potential impact on the habitat and the high amount of discards". Second, it is effect on employment is significant, while production costs are low (Tvedten and Hersoug 1992). It has been estimated by FAO[5], (as quoted in Mathew 2003) additional employment for 1 to 3 persons can be generated in the fishery sector for every full-time fishery in the artisanal fishery. Third, it stimulates the rural economy and reduces rural-urban migration and centralization trends (Diegues 2006).

As Konstapel and Noort stated (cited in Bokea et al. 2000) FAO has estimated that, although it may be a small sector of the world economy, the livelihoods of 100-200 million people directly or indirectly depends on fisheries, and of which 95% are living in developing countries. While Pauly (1997) stated, artisanal fisheries produce almost 50% of world fish supply for human use and also provide employment for around 24 times more than the industrial fisheries. Further, the importance of artisanal fisheries is often explained as the major if not the sole supplier of fishery products for the local market (Lawson 1984). It has been also mentioned that the fishery sector serves as a safety-net with the unpredictability of price fluctuation of agricultural product (IFAD, n.d.).

Government and scholars have been working on the development and management plan of the fishery sector. However, due to the overexploitation of the resources, commonly attention is centred on the management issue (Feeny et al. 1990, Hardin 1968, Mathew 2003, Reis and D'Incao 2000, Salas et al. 2007, Udumyan et al. 2010). On the other hand, regardless of the overexploitation of the resource in the world, there are still under-utilized resources with a very low rate of exploitation particularly in developing countries (Limpus 2001). During 1970's, this under-exploitation has been seen with the establishment of a 200 mile EEZ (Tvedten and Hersoug 1992).

Eritrea is a small developing nation in the horn of Africa. It has been estimated that about 80% of the population lives in rural areas with 67% depending on subsistence agriculture and fishing (IFAD[6] 2010). The contribution of the fisheries sector is not well documented, though significant is assumed (MMR 2007). While IFAD (2010) stated, together with the agricultural sector, fishery sector contributes about 23% of gross domestic product and over 60% of employment. Due to the fact that the agricultural sector is producing only about 60% of national food requirement, Eritrea is considered food insecure (IFAD 2010). In view of this, as Andom Ghebretensae[7] argued (cited in Capitaleritrea 2010) the country endowed with abundant and underexploited fishery resources with a huge potential for national food security in general and poverty reduction strategy of the coastal communities in particular. This is because, Eritrea has many favourable conditions for fisheries development due to the EEZ of 78,703 Km^2 including the 356 off-shore islands mainly located in the Dahlak Archipelagos with a coastline of about 1,155 km in length, stretching to Djibouti in the South to

[5] Food and Agricultural Organization
[6] International Fund for Agricultural Development.
[7] Director General Regulatory Service, MMR.

the Sudanese border in the North[8]. In this respect, the fishery sector is expected to provide a significant contribution.

There is diminutive research done to find out the poor performance of artisanal fishery in Eritrea. The few studies that have been done focused on the overview of the fishery resources and fishing activity. Morgan (2006) indicated, apart from little descriptive analysis of catch levels and fishing effort, no thorough investigation of Eritrea's fishing activities regarding artisanal fisheries has been made to date. However, there are few studies in Kenya, Nigeria, and Tanzania that elucidated the importance of the identification of the determinants of fish catch levels on the utilization of fisheries resources. The research paper was, therefore, aimed at identifying the factors that are responsible for determinants of fish catch levels in Eritrean artisanal fishery. Since we demonstrated that enhancing harvest requires the mechanization of outboard traditional craft, the paper also tried to identify the determinants of the adoption and use of inboard motorized fishing technology. In this respect, it is hoped that the paper has added to the existing literature and will also offer a platform from which further attempts for research would be launched. Despite its limitation, some of the findings might shed insights for artisanal fishery development.

1.3 Research Questions

The study is aimed to answer the following questions.

Main Research Question:

What are the key determinants that affect the utilization of fishery resources to enhance the scanty artisanal fish catch levels?

Sub-Research Questions:

- What are the determinants of fish catch levels?
- What are the determinants of the use of inboard motorized fisheries – Sambuck - against the less capable and relatively traditional outboard motorized boats - Houri?

1.4 Basic Line of Argument or Hypothesis

We hypothesised that:

- Fishing boats which are restrained to coastal fishing by technological constrictions tend to catch less fish, regardless of the fishing gear they employ. Thus, it is expected that the means of boat propulsion highly and significantly elucidates the catch level, using inboard motorized engine fisheries produced more, ceteris paribus.

[8] http://www.seaaroundus.org/eez/111.aspx (Accessed on 21 July, 2011)

- There is significant difference among the fisher's characteristics, household resource endowment and technological characteristics in explaining the adoption and use of better fishing technology.

1.5 Limitation of the Study

It is imperative to throw light on the limitations of the study. First, the study used cross-sectional data which entails the inability to control for unobserved heterogeneity. Secondly, it is based on small sample size survey. Hence, inference to the entire artisanal fishing population would be hard to construct. Further, the data for instance do not allow us to split the variable access to loan facilities into keeping the fishing operation running and purchasing boats so as to include and treat separately in our analysis.

1.6 Organization of the Paper

For analytical purpose, the paper is divided in to six chapters. Next to the introduction part, chapter two highlights on some of the available literature. The third chapter deals with an overview of the artisanal fishery in Eritrea. The methodology employed, model specification and empirical strategy are provided in chapter four. The findings along with the discussion and analytical explanation are presented in chapter 5. And the last chapter is devoted to summary of the key findings and conclusion.

Chapter 2

Literature Review and Analytical Approach

2.1 Introduction

This section recounts briefly on working definition of artisanal fishery used in this study and relevant existing literature on development of artisanal fisheries as well as previous empirical studies. Building on these previous studies, it closes by giving the analytical framework for both the determinants of catch level and adoption of fishing vessels.

2.2 Definition of Artisanal Fishery

Various scholars have been arguing to define the term artisanal fisheries from different standpoint to represent different points of view and socioeconomic dimension in different national context (Freire and García-Allut 2000, McGoodwin 1995, Sowman 2005). Artisanal fisheries represent as employing low or medium technological equipment, fishing ecosystem located nearby coastal waters, and simple fishing chain operation (Freire and García-Allut 2000). While FAO, (2011a) refers artisanal fisheries as:

> Traditional fisheries involving fishing households using relatively small amount of capital and energy, relatively small fishing vessels, making short fishing trips, close to shore, mainly for local consumption. In practice, definition varies between countries, example, from gleaning or a one-man canoe in poor developing countries, to more than 20meter trawlers, seiners, or long-liners in developed ones.

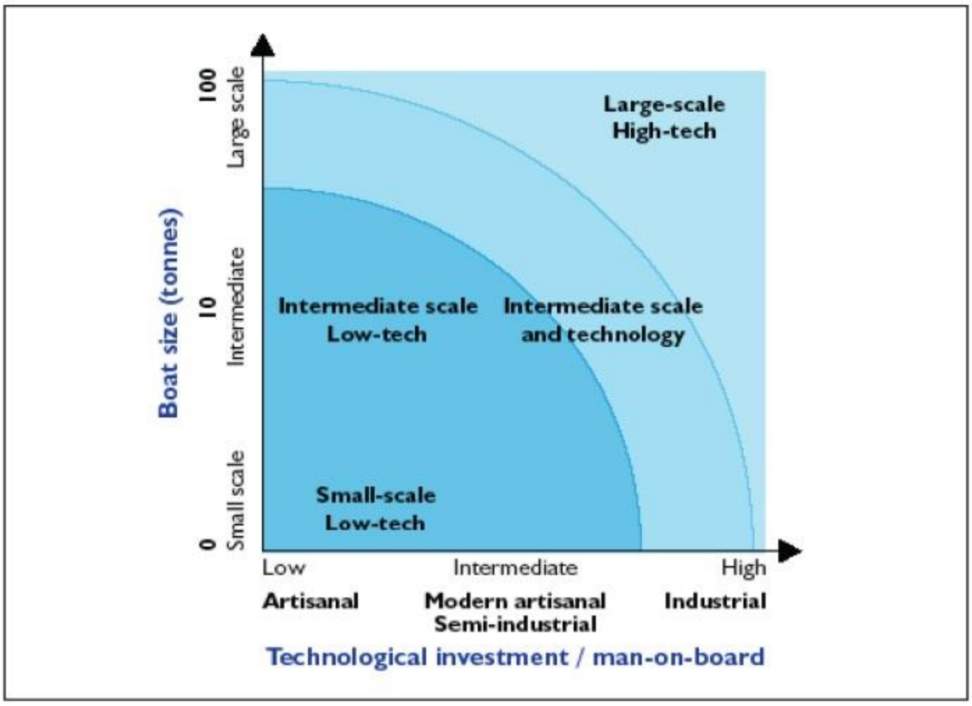
While McGoodwin (1995:9) labelled artisanal fisheries as:

> The artisanal fishers' art is the skill, experience and intuition they apply to their fishing effort.

Given the different socio-economic context, the term artisanal fishery could represent distinct implication (Mathew 2003). He claimed, since countries tagged the term with different specific illustrations, it is not possible to establish elegant definition of the term artisanal fishery. In Madagascar, for instance, it refers to domestic as well as international market oriented motorized fishing, in Fiji fishing pointed to domestic market, in Indonesia and Malaysia employed for gear-specific, in Peru defined in terms of carrying capacity (ibid). Further he mentioned, in India, Chile and Canada it refers to vessel specific, vessel length and tonnage specific, and inshore fisheries defined by vessel length respectively.

FAO (2011a), used to categorize artisanal fisheries based on the size of fishing boats and the low technological investment (figure 2.1). Accordingly, fisheries that use small fishing boats with relatively low technological investments stated as capital investment per man-on-board are considered to be artisanal. Okeyo (2010:8) argued "boats mostly motorized which fall within an intermediate range of size and low technical complexity are usually called modern artisanal or semi-industrial. Beyond this range is the industrial category". These graphical boundary positions may not represent the above diverse specific illustration among different countries and is not easily distinguishable ((FAO 2011a, Okeyo 2010). However, the position and shape of these categories and their connection seems to remain unchanged (FAO 2011a).

Figure 2.1 Fishery Classification Level



Source: Adopted from FAO (2011a)

Artisanal fishery in Eritrea refers to fishing activity by local traditional fishermen mainly practised using Houri and Sambuck. This ranges from average 40HP (Horse Power) outboard petrol engine with 4 to 9 meters to relatively better inboard diesel engine fisheries of average 85HP with 11 to 18 meters (table 3.3). According to FAO (2011a), this category situated somewhere lower left-hand quadrant of figure 2.1 above. Here boats are small with fishing techniques of different combination of gillnets, hook and line (Mahmud 2008) and low technological investment, and with limited fishing grounds concentrated and scattered within 20km to 160km from their main harbour and sometimes reached up to the Eritrean EEZ (Tsehaye 2007). In conclusion, the term artisanal fishery in Eritrea and thus we used in the study is an economic sense of fishing specific performance which encompasses the socioeconomic condition of the fishers while other may emphasizes ecological dimension.

2.3 Development of Artisanal Fisheries

Owing to resources over-exploitation, most countries are increasingly concerned and due attention to sustainable management of their resources. Consequently, the literature concerning development of artisanal fisheries is very scarce comparing to its counterpart, management of the resources. However, there are some countries, like Eritrea, that have not yet utilized their potential yield. Morgan (2006:217) argued that "...landings for all major species are significantly less than MSY and therefore fisheries' planning in Eritrea in recent years has concentrated on development activities to increase landings…" As such, it is vivid that the main concern is confronted with many development challenges of the sector.

The production of artisanal fisheries can be constrained by a number of factors. Lack of capital and low level of technology is among the foremost ones (FAO 2011a). A study on the status of artisanal fisheries along the Indian coast shows that there are about 76,596 small boats comprising of Dugout canoes, Catamarans and Plank-built (Viswanathan et al. 2001). Nevertheless, due to their limited capacity, these boats contribute small share of total landings of the region. Similarly, access to fuel, catch storage, crew requirements and onboard processing facilities are also responsible in limiting the fish catch (Limpus 2001).

The low technological artisanal fishing techniques in Gulf of Aden and Red Sea area in Yemen (Wagenaar and D'Haese 2007), Lagos state, Nigeria (Akanni 2008) and Kenya's south-coast (Okeyo 2010) can be stated as examples of low level of technology and capital intensity that can responsible for scanty fisheries production. Difficulties in resource accessing and effective fishing gears and practices hampered the development of new potential fisheries in Southeast Asian countries (Limpus 2001).

Another equally important factor is related to processing and marketing of their catches. Lack of appropriate infrastructure, standard processing techniques, financial assistance to improve the production and marketing know-how are challenges of the sector (ibid). Diegues (2006:12) argued that "fish marketing, improvement of the quality of fisheries products, and the processes of intermediation within the market chain continue to be the critical points for the development of artisanal fisheries...". While Wagenaar and D'Haese (2007) in their descriptive study concluded marketing channel is highly hampering the sector. They accentuated this argument that in-addition to higher rejection rates of fisheries products, superior cost of transportation, involvement of brokers and substantial auctioning commissions contributed to a costly marketing channel.

Competition and conflict with industrial fisheries is also pointed as another impeding factor. In the Gulf of Aden, for instance, there is frequent competition for cuttlefish and demersal fish between trawlers and artisanal fisheries (Bonfiglioli and Hariris 2004). While Lawson (1984) also indicates that this competition results in depletion of fishery resources that has forced artisanal fishermen to come back with empty boats. Wagenaar and D'Haese (2007) exploration study on the development of artisanal fisheries in Yemen found that competition with large fleet is an important impeding factor particularly for Red Sea area fishermen.

In the past, fisheries development approaches as mitigation strategies have been discussed. Increasing fishing efforts are among most desirable recommendation (Christy 1997). He suggested that, improvements in landing and processing facilities, transportation networks, provision of low cost ice and fuel, efficient gear, and enhance marketing situation can increase catch level. As Wagenaar and D'Haese (2007:272) states, "there is also a clear need for investment in local infrastructure, such as landing sites that facilitate safe landings, effective market distribution, and market information systems. These improvements would contribute to reductions in the costs of finding buyers, transport, and lower rejection rates".

The weakening role of the government in promoting development of the sector in Brazil for instance, contributed to the absence of coordinated effort of the sector and eventually worsening the condition of artisanal fisheries (Diegues 2006). Lawson (1984) explains that fostering artisanal fisheries development has to be the centre theme of government role. She further stated, in many schemes of developing artisanal fisheries were become futile, not due to the scarcity of loan-able funds, rather the absence of a coordinated fisheries planning instruments. Hence, why the resource is not being harvested to full potential should be the initial objective which required understanding of the determinants of fish catch level (Limpus 2001).

2.4 Previous Studies

Literature on modelling artisanal fishery production and determinants of fishery technology are scarce. However, there are superb bits. These comprise Ikiara (1999), Mwakubo et al (2007), Inoni and Oyaide (2007), Akanni and Akinwumi (2007), Akanni (2008), Wetengere (2009) and Akanni (2010) and briefly revised.

Ikiara (1999) estimates Kenya's Lake Victoria fisheries production function to identify the key dimension of effort that lead to catch variations using Transcendental Logarithmic (translog) and Cobb-Douglas functional form with data from 482 fishing unit sample. The former could not be used due to degree of freedom and multicollinearity problems, however, the later suggested, vessel mode of propulsion, crew size, fishing experience and number of days fished were highly significant in explaining catch variations.

Mwakubo et al (2007) examined the determinant of catch level using socio-economic, ecological and fish catch data from Yala swamp of ten landing sites. To incorporate seasonal variation data were obtained from June 2004 to January 2005 for the period of ten days in each month. Using Cobb-Douglas function, estimations showed that household sizes, length of boat, total nitrogen, and phosphorus were positively correlated with catch level. While educational level, age, non-fishing income, level of nitrates and chlorophyll-a were found to be correlated negatively.

Inoni and Oyaide (2007) model the effect of socio-economic factors on artisanal fish output using a sample of 198 fishers in the South Agro-ecological zone of Delta State. Examination result from the postulated economic model indicated that fishing vessels, household size, labour, fishing experience, gender and season had statistically significant effect on catch level. The model justified using Ordinary Least Square (OLS), the logarithmic functional form is selected as the most commonly used and also coefficients are direct elasticises. They concluded that production credit, adequate investment and re-investment in fishing vessels, and input subsidy are required policy option to up-scaling artisanal fishery production and maintain higher catch.

Akanni and Akinwumi (2007) modelled the probability that a fisher adopting the use of power-driven fisheries against manually propulsion boats for Lagos state, Nigeria using a cross-sectional sample of 222 artisanal fishers. The probit model was used for investigation. Estimation result demonstrate educated fishers, access to extension contact, availability of credit facilities could increase the probability of adoption and use of outboard engines relative to the traditional canoes. Evidence from the study showed the importance of adoption and use of relatively advanced fishing technology, demanding powerful boats to increase and maintain higher catch level. Consequently, the study concluded use of better fishing technology to move away from fishing systems that can only function in the nearby coastal resources.

Akanni (2010), on his other studies, to scrutinize the peculiarities of the fish catch level using the maximum likelihood of stochastic catch frontier, found that labour use, credit, and cold storage facilities as major determinants of the fish catch. The result suggested that increase in the use of these resources and empowering artisanal fisheries to acquire more versatile and larger fishing boats to increase fishing capabilities to offshore and deep area where fisheries resources are abundant can possibly increase their catch.

The paper by Akanni (2008) on catch levels and capital investment of artisanal fishermen is an application on determinants of the use of motorized fishing technology, using cross-sectional sample data of 222 fishing households. The estimated probit model suggests the low catch level in the study area could be tackled by acquiring large and versatile motorized fishing boats. He further suggested adoption of these fishing vessels could be made achievable through promoting credit facilities at very low interest rate as well as the establishment of more and easily accessible microfinance.

Wetengere (2009), investigated factors responsible for adoption of fish farming using cross-sectional data from 340 randomly sampled respondents in Eastern Tanzania using the probit model. Results showed, adopters were more likely to be younger, educated household, bigger household size, own bigger land size, acquired fish harvesting awareness, and if the technology is less risky. He justifiably modelled the adoption decisions on the base of relative utility consideration, adopt a fishing technology when its expected utility is in excess of the utility from other activities.

Eritrean fishing, however, is not well monitored and there is very few published and available information[9]. In spite of this, preliminary descriptive studies have been conducted at identifying constraints facing the sector. Result

[9] http://bycatch.nicholas.duke.edu/ (Accessed on 2 August 2011)

suggested inadequate fishing equipment, means of fish processing, facilities to preserve catch, transport and access to markets and credit are major constraints. While other showed absence of dynamic fishing cooperatives, lack of support from the MMR, limited fishing effort, obsolescence and limited capacity of the traditional outboard engine and sky rocketing price of petrol as major barriers which have made the production capacity of fishermen to drop.

2.5 Analytical Approach

Fishery Production

Following the approach by Gordon (1954) and Schaefer (1954), bio-economic production analyses of fisheries has been the centre of discussions. This approach combined biological and economic production function to examine the relationship between catch and effort (Campbell 1991). Here, production function is defined as the relationship between the effort applied and the amount of catch realised (Anderson 1986). The economic production function adopted by Schaefer, and later applied by Campbell and Hall (1988) using data on the Tasmanian rock lobster, is a form of the Cobb-Douglass specification production function (Campbell 1991):

$$h = AE^{B_1}X^{B_2} \qquad \beta_1=\beta_2=1 \quad \text{.......................................}1.1$$

Where h is the harvest rate, A is constant, E the fishing effort, and X the stock. The harvest rate, h, can be specified as in a general form of the economic production function (Campbell 1991, Ikiara 1999):

$$h = f(E,X) \quad \text{.......................................}1.2$$

From (1.2), in general, the level of catch at a given time period is a function of the effort E and the stock of fish, X. However, estimating a form of this economic production function is often hindered by a problem of obtaining the estimation of stock size, X (Campbell and Hall 1988, Mwakubo et al. 2007). As a coping strategy, proxy for fish stock, such as catch per-unit of effort, has been used but this creates econometric inconvenience (Campbell 1991). Nevertheless, when cross-sectional data are used or specific location analysis applied, the size of fish stock, X, assumed to be constant (Campbell 1991, Ikiara and Odink 1999, Mwakubo et al. 2007) and hence the economic production function is separable and given as (Campbell 1991, Ikiara 1999):

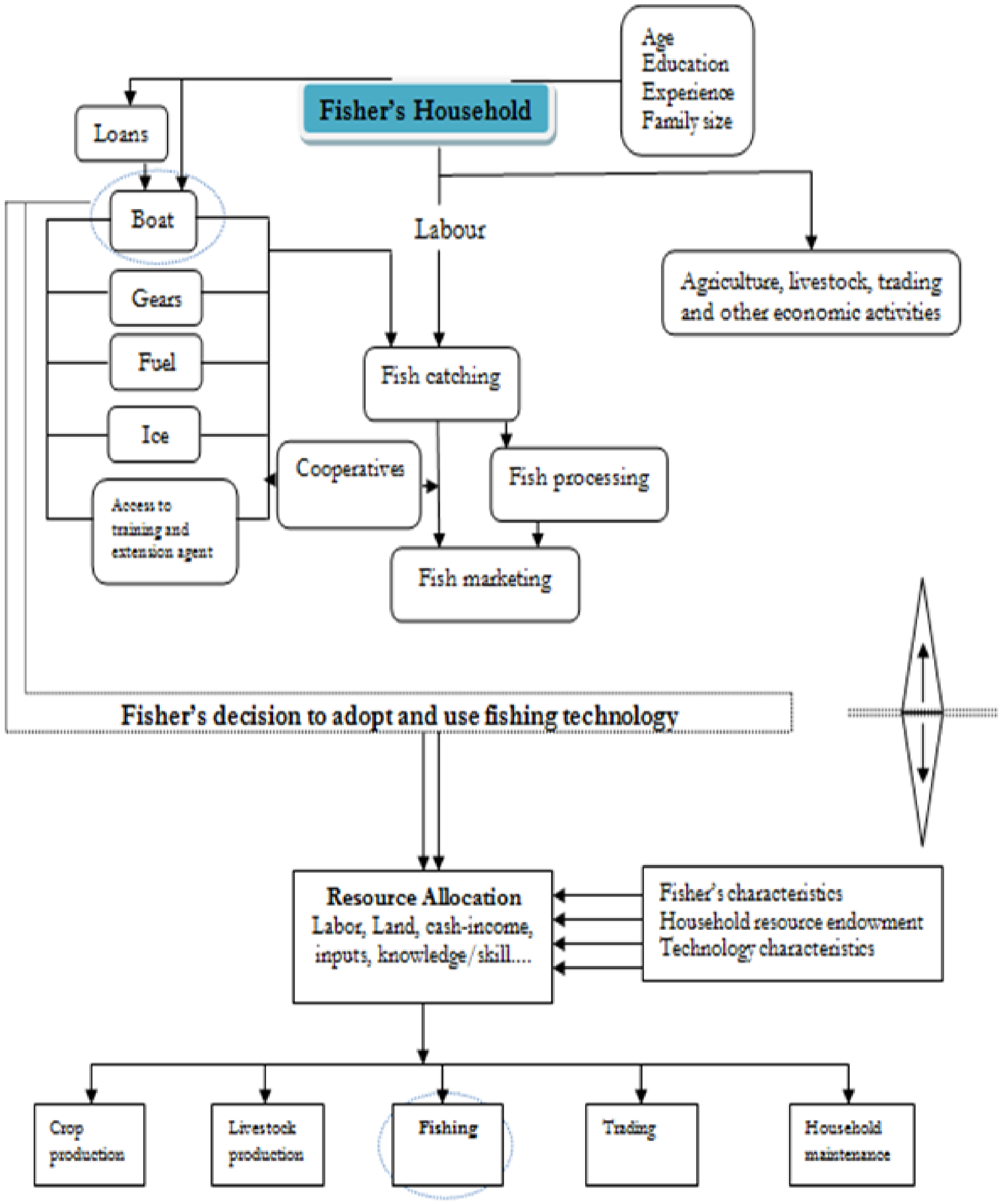
$$h = f(g(E),X) \quad \text{.......................................}1.3$$

According to Hannesson (1983), estimate of fish stock based on Lofoten cod fishery production function, could not reject the hypothesis of separability. This indicates that under such circumstance of production function, the size of fish stock can be eliminated as explanatory variable (Campbell 1991). The economic production function, subsequently, specified as:

$$h = f(E) = f(E_i) \quad \text{.......................................}1.4$$

Where h is the catch, in our model the fish catch per day. E_i, i= 1, 2, 3...stands for, a vector of inputs such as labour, capital, and resources[10]. The justification behind equation 1.4, fishers employ different component of fishing effort, E, to produce a given fishing unit's catching power (Ikiara 1999). It is thus, this composite input, E that determines the level of catch.

Figure 2.2 Fisher Household Economy



Source: Modified from Angelo and Khaled (2004) and Wetengere (2009)

[10] These vector of inputs are briefly discussed in section 4.4.1 of chapter 4

Figure 2.2 (top), illustrates how a fisher household functions. It presents the different elements in the process of fish catching, namely labour, capital and resources. Within this analytical framework, the study tried to investigate to what extent these elements influencing the artisanal fish catch level. The bottom part of figure 2.2 dealt with adoption and use of better fishing technology.

Adoption and Use Choice

Usually when fishing technology is introduced or a fisher sees or hears about better fishing technology, they are usually faced with a dilemma of whether to adopt and use it or not (Wetengere 2009). This needs household resource allocation choice among various livelihood activities (figure 2.2, bottom). According to Temu (as quoted in Wetengere 2010), household resource allocation decision is often expressed in terms of two-stage process. Accordingly, priority is given to securing food requirements and then income maximization with the remaining resources.

It is assumed that fishermen make adoption and use of choice based on utility consideration (Nguyen et al. 2007). This study takes the approach employed by Batz et al. (1999) and later used by Wetengere (2009) in which the likelihood that better technology adoption is expressed in terms of its relative utility. Therefore, in the case of Sambuck fishery[11], a fisher is expected to adopt and use when the expected utility of the Sambuck fishery exceeds that of other alternative activities. This is to say, "comparing various technologies that are utilized, fishers will use a technology if its utility exceeds that of other activities, in which utility of an activity is measured in terms of its contribution to household food and income security" (Wetengere 2009:29).

Based on the adopted approach, fisher's utility function consists of a range of factors, fisher's characteristics, resource endowment, and technological characteristics. This is suitable because household resources are allocated over various activities on the basis of these identified factors (ibid). Consequently, the question of technology adoption and use or not was dealt using a binary choice model, probit, as:

$$y_i = \beta_0 + \beta_1 X + \beta_2 Y + \beta_3 Z + \epsilon_i \quad \text{(2.1)}$$

Where, y_i is the likelihood that fisherfolks adopt the use of Sambuck fishery or not as function of vector of explanatory variables, X fisher's characteristics, Y technology characteristics and Z household resource endowment and β's are parameters. While ϵ, is an error term representing unknown parameters. In this conceptual analysis, therefore, expected utility from adopting and use or not Sambuck fishery considered as follows:

[11] A brief characteristic of Artisanal fishery is presented in section 3.3 of chapter 3.

EUISFA=f(*determining factors*)+ϵ_i

EUISFN=f(*determining factors*)+ϵ_i

Where, EUISFA=*fisher's expected utility from Sambuck fishery*

EUISFN=*fisher's expected utility from not adopting and using Sambuck fishery*

Then in equation 2.1, when the technology adopted and used, y_i=1, if $\frac{EUISFA}{EUISFN} > 0$, or not, y_i=0 if $\frac{EUISFA}{EUISFN} < 0$

Consequently, the probability that fisher adopts and uses Sambuck fishery technology is the likelihood that expected utility attained from Sambuck fishery technology is greater than the expected utility derived from other activities or not adopting this technology (Wetengere 2010).

2.6 Conclusion

Literature review accentuated that artisanal fisheries production constrained by many challenges. Prominent among these are low technology, poor infrastructural facilities, marketing conditions and emphasis on industrial fisheries. However, credit schemes showed paradoxical review. At one end shortage of credit on the other side lack of integrated planning instrument rather than shortage of loan-able funds were mentioned as impeding artisanal fisheries development. The discussion on sparse previous empirical works seems to conclude fishing vessels is the main determinant of fish catch, as a means to move away from traditional fishing system and acquire more versatile one to maintain higher catch. Based on this, the adopted approach, the catch rate is defined by the vector of inputs which constitute labour, capital and resources. The relevance of better fishing boats necessitated the investigation of its adoption and use. The relative utility derived from the given technology versus other activities as a function of fisher's characteristics, resource endowment, and technological characteristics employed to examine the likelihood of adoption and use of relatively better fishing boats.

Chapter 3

An Overview of the Artisanal Fishery Sector in Eritrea

3.1 Introduction

The artisanal fisheries sector has a long-standing tradition in Eritrea. Fishing traditionally has been the main source of livelihood for the coastal population of Eritrea in general and those who live along the coast in particular. This chapter traces the development of artisanal fishery sector in Eritrea with an attempt to highlight the fishing effort and the performance of the artisanal fisheries vis-à-vis the potential of the Eritrean marine waters.

3.2 Historical Review and Current Exploitations

Eritrea had an active artisanal fisheries sector with yearly catches reported exceeding 25,000MT in 1954 (appendix A, table 3.1). Majority (over 80%) was a small pelagic species mainly sardines and anchovies that were processed into fishmeal for export to Far East and Europe markets (FAO 1993). Unlike other fisheries, neither the biological nor the physical factors, rather the political and socio-economic settings governed the Eritrean artisanal fisheries development in the period 1950s – 1990s (Morgan 2006).

In 1930s and 1940s during the Italian and British regime the fishery changed from a subsistence level using some canoes and small plank boats and expanded with the introduction of motorized boats to commercial one (Pasience 2009). Based on Grofit (1971), table 3.1 shows the record of landings from 1954/55 to 1983/84. Total production exceeds 25,000MT in 1954 and fell from 21,000MT in 1966 to 14,000MT in 1967. This large drop in production is mainly due to the closing of the Suez Canal which blocked the most economical export route of the fish meal industry in Eritrea (Morgan 2006). As mentioned by Tsehaye (2007), until beginning of 1970s, the fishery were showing a steady state of development and being important to the economy of the country with estimated fleet size around 800 wooden motor boats. Likewise, Grofit (1971) stated the period with better techniques of fishing and well organized and developed integration for distribution and marketing both at local and international levels.

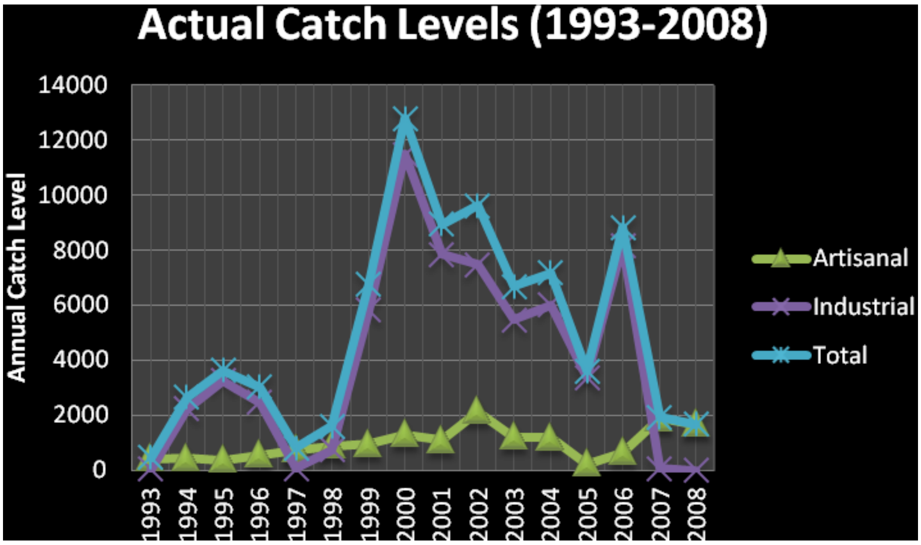
By 1972 landings went down drastically to 4MT and because of the continuous increasing internal strife for liberation, the fishery sector almost collapsed with landings dropped to 0.15MT in 1977. The trend continued to drop and further disruption due to the warfare resulted in numerous fishing facilities totally destroyed and eventually local fishermen increasingly turned to some other activities with majority of them fleeing to neighbouring regions (Pasience 2009). Consequently, only 328 tonnes of landings registered in 1980 (Morgan 2006). The growing internal strife and subsequent instability led to the complete collapse of the fishery industry. It is only in 1993 after the end of the war for independence, the sector came to a renewed development (ibid).

After independence the sector revived as the government of Eritrea in collaboration with development partners has made an intervention that are supposed to support the coastal communities and enable the sector play a role in building the nation's economy (MMR 2007). As a result, artisanal fish landings revitalize steadily from about 200MT in 1980s to 1664MT in 2008 (figure 3.1).

The trend further indicates, artisanal fish landings reached its apex in 2002 with annual catch of 2,130MT. However, the KII attributed this to the introduction of Yemeni fishermen from 2000 to 2002 to replace the local fishermen. This is because the Eritrean fishermen were co-opted in to the military service for the Ethio-Eritrea boarder conflict. However, as the KII further mentioned, in 2003 due to political and other related problem, Yemeni fishermen were restricted access to fish and thence artisanal production faced with a continuous and further drop. Nevertheless, in 2007 majority of fishers have returned to the sector as the boarder condition seems in stalemate situation and thus landings started to revive again (Pasience 2009). In sum, in the last 20 years, the landings has been growing steadily, however, artisanal fisheries catch level still remains at a very low rate with an average yearly catch of about 1,000MT.

Despite the fact that the coastal and islands of Eritrean Red Sea is highly conducive and graces artisanal rather than industrial fishery, the latter had a contribution of minimum of 80% of the total catch level (figure 3.1). Furthermore, while both of which operate under a licensing system, the management of the resources is based on an open and regulated access respectively for artisanal and industrial fisheries (Tsehaye 2007). Even though, entry to the fishery sector is free, the coastal community of artisanal fishery is entirely dominated by the Afar ethnic, who retain their traditional rights and continue to occupy the settlements (KII 2011). The livelihoods of these settlements are focused mainly on marine fish resource. Nevertheless, the artisanal fishery sector is yet contributing very low annual catch.

Figure 3.1 Artisanal and Industrial fish landings (MT)



Source: Author's own illustration from Pasience (2009)

There are various MSY short-term studies conducted between 1956 and 1998 (table 3.2). Though, these estimates are extremely tentative and most importantly many are based on research and surveys undertaken many years ago, only one fisheries potential stock survey conducted in recent years (MMR 2007). In addition, most of these estimates were "...based on catch rates, on some experimental fishing, or on extrapolation from other areas" (Tsehaye 2007:9). These MSY estimates range from 40,000 to 80,500MT year^{-1}. The MSY reveals that small (coastal) pelagic, mainly anchovies and sardines (Morgan 2006) accounted for the majority of the potential yield constitute about 50,000MT year^{-1}. While large pelagic fishery accounted for relatively small, about 5,000MT year^{-1} and demersal were estimated around at 18,000MT year^{-1}. The rest of the MSY includes shrimp, sharks, lobster and some other minor species (ibid).

The KII indicates, these potential resources estimates should be treated with caution as the studies were not considered to be comprehensive, much of the estimates done years ago, and the methodologies employed are linked with large margins of error. Opposed to this view, some believe that the estimates to be too low. In-support of this, MMR (2007) argued, comparing to the productivity of other areas of the Red Sea continental shelf, the MSY estimates done for the Eritrean continental shelf is noted to be very low. The general consensus seems that, given the uncertainty of these estimations and the anecdotal evidence that a portion of the catch is unreported, it is sensible to put reference point which is not in excess of the lower limit of the MSY cited in table 3.2 (KII 2011).

Table 3.2 MSY estimation developed from different researches (1000MT year-1)

Fishery Resource	MSY[A]	MSY[B,C,D]	MSY[E]	MSY[F]	MSY[G]	Lowest estimate	Highest estimate
Demersal fish	10.0	10.0–15.0	8.5	18.0	17.0+5.0 (reef)	8.5	18.0
Coastal pelagic	50.00	50.0	25.0	25.0– 50.0	24.0	24.0	50.0
Neritic and oceanic pelagic	-	-	-	5.0	6.0	5.0	6.0
Shrimp	-	0.5	0.5	0.5	0.5	0.5	0.5
Spiny lobster	-	0.5	-	0.5 – 1.0	0.5	0.5	1.0
Sharks	5.0	5.0	2.0	2.0 – 5.0	5.0	2.0	5.0
Total:	65	66.0-71.0	36.0	51.0-79.5	58.0	40.0	80.5

Sources: Author's own illustration from various independent estimations.
A=Ben Yami (1964), B=Atkins (1956), C=Grofit (1971), D=Aubray (1975), E=Gaudet (1981), F=Guidicelli (1984) and G=Antoine et al. (1998).

3.3 Fishing Effort and Capture Technology

The artisanal fishermen population is very small, not exceeding 3500 (Mahmud 2008). These fishermen are scattered along the shoreline and the islands. Nevertheless, only nearly half of these fishermen are considered to be active (ibid). Cooperative Societies under the umbrella of the MMR are created with overriding aim to support on the provision of training, securing financial assistance, administrative support, marketing and other comprehensive assistance to its members (KII 2011). So far there are 38 fishing village cooperatives with registered members of 1077 (FAO 2011b).

The fishing vessels vary in terms of size and type. The fishing operations are mainly carried out using the two different types of wooden boats, namely Sambuck and Houri (table 3.3 and figure 3.2).

Table 3.3 Situation of Artisanal Fisheries characteristics demonstrating in 2009

Boat Type	Sambuck	Houri
Number of Boats	107	386
Engine-average	Inboard, diesel, 85HP	Outboard, petrol, 40HP
Length-meters	11 – 18	4 – 9
Fishing days per trip	6 – 12	5 - 9
Crew size	6 – 12	4 – 6
Fishing grounds distance	Up-to Eritrea's EEZ limits[12]	Up to 100kms

Source: Author's own illustration from various sources

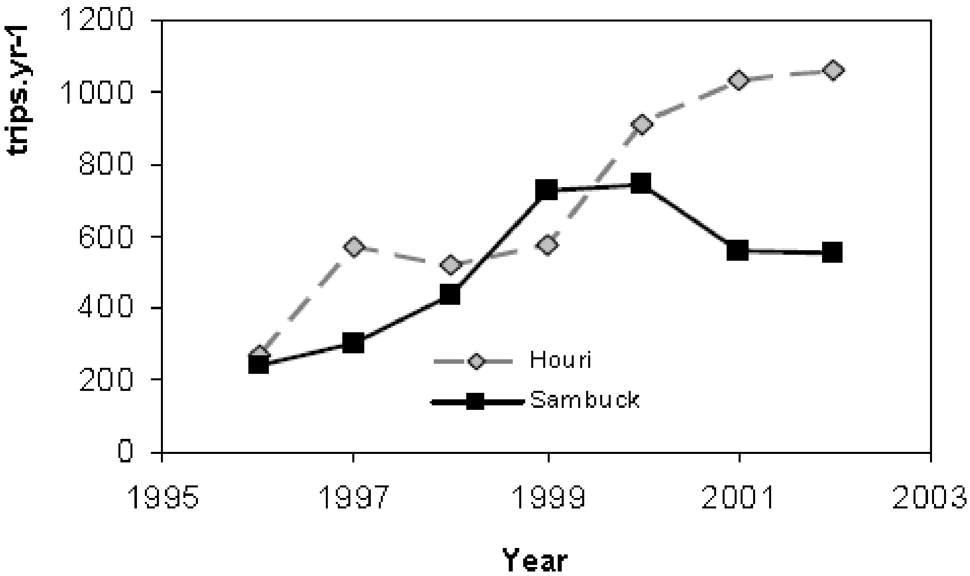
[12] EEZ extends up to 200 nautical miles.

Figure 3.2 The two most commonly used Artisanal Fisheries boats

Source: Top - Sambuck from Travel Adventures (n.d.) and bottom - Houri from Pasience (2009)

Table 3.3 shows, Houri are large in number and small in size, 4 to 9meters in length, equipped with average 40HP petrol outboard engine and crew members 4 to 6. Whereas Sambuck are small in number and large in size, 11 to 18meters with average 85HP inboard diesel engine, crew size of 6 to 12. The boat type and fish hold size, number of crews, ice facilities and its melting rate, type of fishing gears, and other factors limits fishing trips (Tsehaye 2007, Wagenaar and D'Haese 2007). The range of fishing days per trip is 5 to 9 and 6 to 12 respectively for Houri and Sambuck. Generally the trip extended not more than 12 days and on average 2-3 trips per month (Tsehaye 2007). In-addition, Sambuck are more preferable for prolonged fishing and distant trips because they are powerful and large in size. Further, Sambuck are using lower price diesel, they are considered more economical. Thus, being large in size, powerful and cheap diesel inboard engine, Sambuck boats are fishing up to the EEZ limits. While Houri constrained to a maximum limit of 100kms.

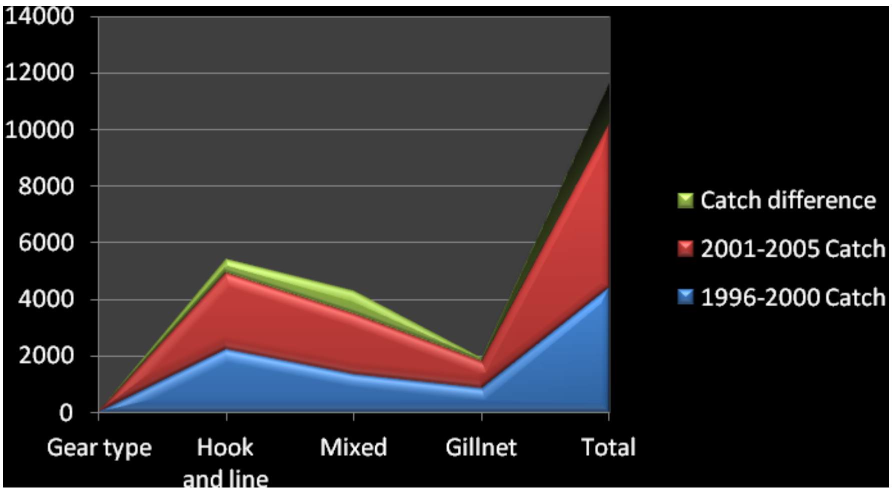
Figure 3.3 Total efforts in terms of trips per year.



Source: Tsehaye (2007)

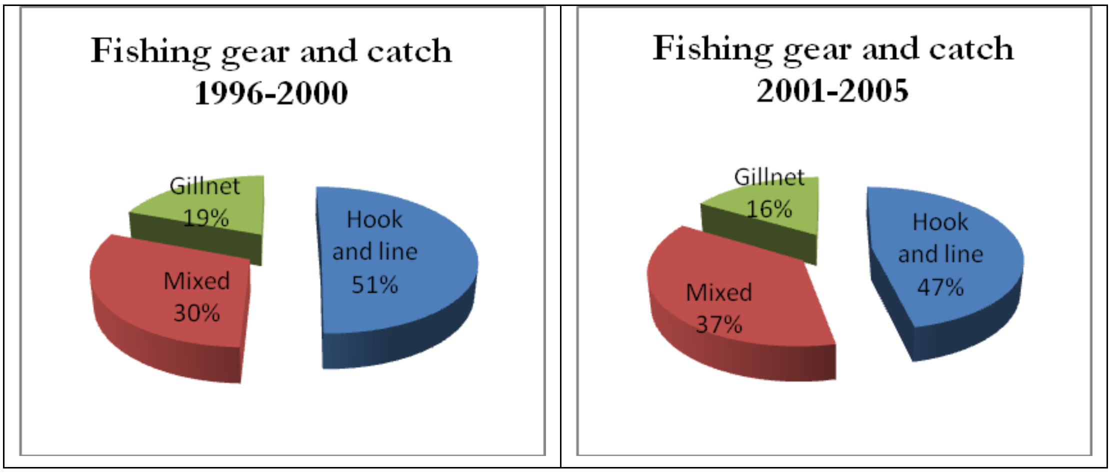
The number of fishing trip per year has been rising (figure 3.3). Total annual fishing effort which is expressed in terms of trips per year for Houri showed a rapid increase from 1996 to 1997 and from 1998 to 2002. While Sambuck showed steady increase from 1996 to 2000 and then declined rapidly. Except for the year 1999, the total effort for Houri was always greater than Sambuck. This could be due to the relative small size and limited fishing trip distance which led the Houri fishers to undertake frequent trips than staying at the sea for prolonged days in distant trip.

Figure 3.4 Fishing gear and catch (MT)



Source: Author's own illustration from MMR (2007)

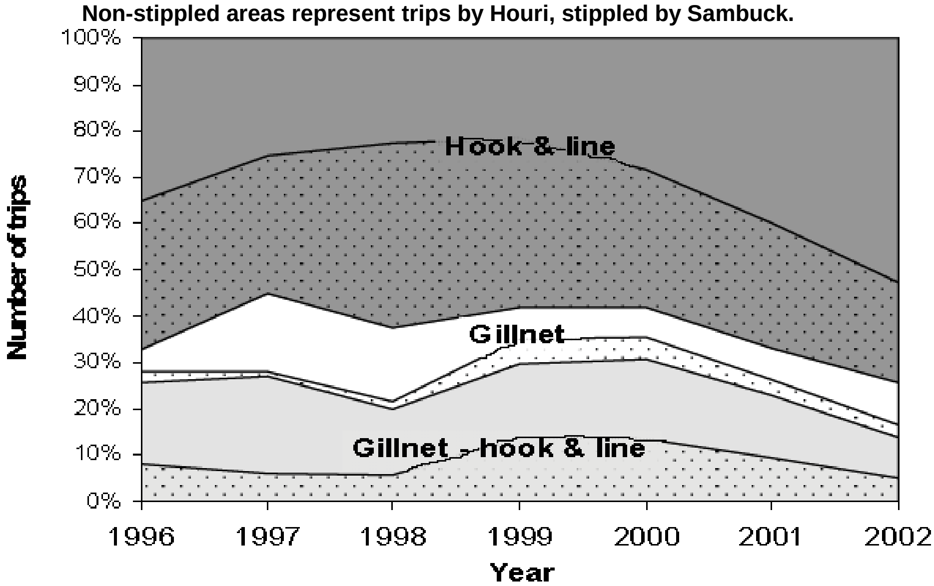
Figure 3.5 Percentage of catches using hook and line, gillnets and combination of the two gears from 1996 to 2000 and 2001 to 2005.



Source: Author's own illustration from MMR (2007)

Capture technology in Eritrea is still undeveloped, having only slightly changed (figure 3.4 and 3.5). Artisanal fisheries are employing hook and line, gillnets or a combination of both. Hook and line, which is the most prevalent gears, accounted for about 51% and 47% of total catch from 1996 to 2000 and 2001 to 2005 respectively. While mixed gears reported for 30% and 37% and gillnet represent 19% and 16% of the same period. Further, over 45% of the capture technology explained by hook and line. The total fish catch in the first five years, 1996 to 2000 was 4,416MT compared to 5,809MT of the next five years, net increment of 24%.

Figure 3.6 The percentage of trips using the existing fishing gears from 1996 to 2002. Non-stippled areas represent trips by Houri, stippled by Sambuck.



Source: Tsehaye (2007)

The effort from the percentage of number of trips in relation to gear composition showed, Houri used to be relatively more important, except for hook and line (figure 3.6). In both types of boat, over 30% of the trips were undertaken by the most prevalent gear, hook and line. Until 1999 Sambuck showed more trips and eventually Houri took the lead with hook and line. Since the size of these gears remained unchanged over this period, no significant and apparent change in technical specification and gear composition has been observed which probably elucidate the catch levels (ibid).

3.4 The Physical Setting of Eritrea's Fisheries

The artisanal fishing primarily takes place along the coastline of the Eritrea's marine water. This coastline is roughly 1720km long, comprises of about 1155kms continental coastline, and 565kms around its 356 islands on the continental shelf (Map 1). The continental shelf covers approximately 52,000km^2, in the 0 – 200m depth, is equal to about 40% of its total land area (FAO 1993). The continental shelf is wide around the Dahlak and narrowing down to the Southern coast part in the area of Babel-Mendeb. This marine water tagged as a home for over 1000 species of fish and about 220 corals species, all are commercially valuable (FAO 2011b).

The fishing practise is mostly concentrated around a group of over 200 Dahlak archipelago's islands scattered within 20 to 160km far away from Massawa, main port of Eritrea (Tsehaye 2007). Around quarter of the continental shelf is represented by Dahlak archipelago main fishing grounds and about 20% of total continental shelf area is within 30m deep, where majority of these fisheries operates, particularly Houri (Salih 1998, Guidicelli 1984).

Despite the debate on the primary productivity[13] (PP) of the EEZ waters of Eritrea, recent analysis and visualization studies, shows high PP environment (mean of 1263 $mgC \cdot m^{-2} \cdot day^{-1}$), mainly the Southern part (in support of the work of Getahun, 1998), four-to-five times higher than other areas[14]. Therefore, the low PP misconception that has been originated, probably, although not sure, since 1960s after the review work of Ryther and others and also showed later in the work of Edward (1987) should be buried (I. Tsehaye, personal communication, 29 June 2011).

The seasonal pattern of the wind defines two seasons. Informants indicate, during summer, hot season North-Westerly winds hardly exceed 10km/hr with narrow tidal ranges, less than 1m. This season ranges from May to September. The KII also indicated in winter, cold season, extending October to April, and wind velocities range from 16 to 65km/hr blowing South to South-Easterly.

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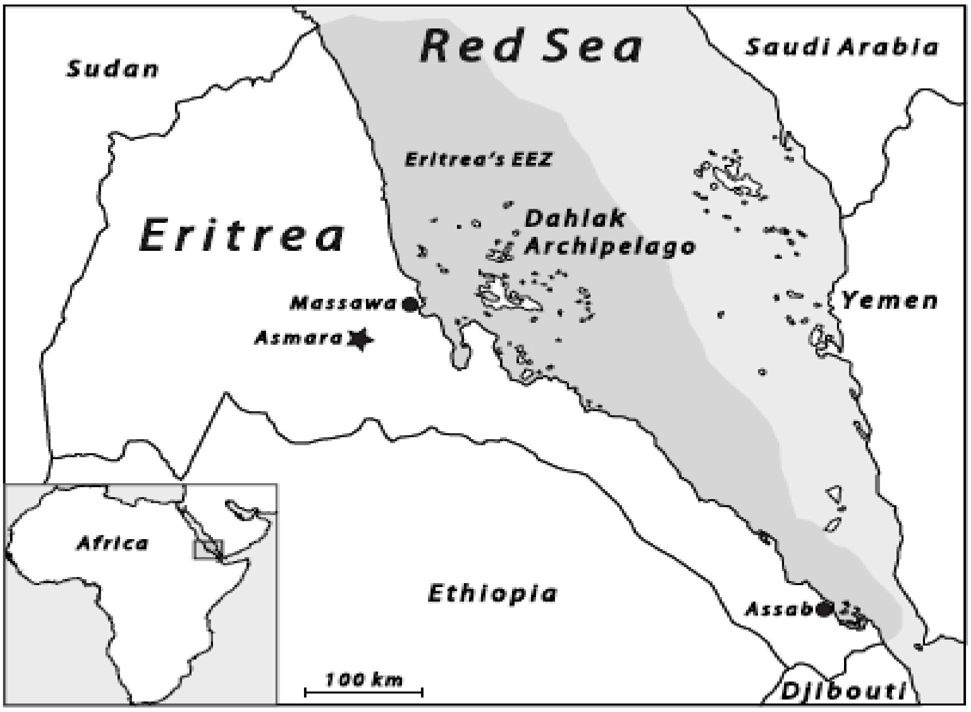
13 PP is the flow of energy starts with the fixation of inorganic carbon (sunlight) by living organism leading to the accumulation of energy and measured by kilocalories (milligrams), by the consumption of CO_2 or production of oxygen which is equal to $mgC \cdot m^{-2} \cdot day^{-1}$ (http://kingfish.coastal.edu/biology/sgilman/778PrimProd.htm Accessed on 21 July 2011)

14 http://seaaroundus.org/eez2/PPtable.aspx?eez=111&FAO=0&country=Eritrea (Accessed on 21 July 2011)

The seasonal pattern affects fishing activities to a large extent. During summer, fish resources remain in deep waters, distant fishing grounds and subsequently capture technology might need changes and prolonged fishing trips required. Long fishing trip further imputes to change in handling and preservation and thereby post-harvest loses could be substantial and fish harvest diminishes. While in winter, the high wind velocity hinders artisanal craft, particularly Houri fishing expedition. Further, there is no official closing season for artisanal, but for industrial fisheries.

Map 1. Map of Eritrea showing physical setting of Eritrea's fisheries



Source: Adopted from Grofit (1971)

3.5 Conclusion

Although the derived MSY suggested 40,000 – 80,500MT fish resources can be exploited, the general consensus seems to be not in excess of the lower limit of this yearly potential yield. Historical analysis pointed that artisanal fishery in Eritrea has been versatile. However, the thirty-year war for independence vexed the sector. It started to come to a rehabilitated development after 1993. Owing to the paltry growing in landings, the performance was unsatisfactory. This is mainly due to the majority of Houri boats which are relatively traditional and less resourceful outboard petrol engine with restricted fishing expedition around the inshore predominantly during winter fishing season.

Chapter 4

Methodology, Model Specification and Empirical Strategy

4.1 Introduction

This chapter focuses on the methodology and data analytical tools employed in the study. It provides the data type and collection method as well as the analytical techniques used in the study for both the determinants of the catch level and use of inboard motorized fisheries against the less capable and relatively traditional outboards boats among artisanal fisherfolks.

4.2 Data

The study mainly employed quantitative data to examine the determinants of catch levels and use of inboard motorized fishing technology. Moreover, we incorporate qualitative data to uncover and get more insight on our quantitative data relationship and identifying major constraints of the artisanal fisheries. This approach of research techniques offers a broad knowledge and understanding of our research topics to address the research problem.

4.2.1 Quantitative Sample

The study uses the cross-sectional data from FDP baseline household survey, conducted in Northern and Southern Red Sea regions between the fourth and sixth of May 2010 by the SMAP Institute of Training, Education and Consultancy under the direct supervision of the MMR. This survey is meant to give baseline information which is relevant to the socio-economic characteristics and livelihood condition of the coastal communities. Specifically, this data provided us with information on the socio-economic characteristics of artisanal fishing households, their capture technology, accessibility to credit facilities, training, fishing input requirements, and so on.

The household survey was designed to draw samples from the two regions of the communities that are representing artisanal fishery livelihood setting. In these two regions eight sub-regions were identified. Two-stage stratified cluster sampling was employed. First, clusters either villages or communities as a primary sampling unit were selected using probability proportional to size sampling. Second, households were treated as a secondary sampling unit and selected using linear systematic random sampling method.

The initial sample size of the baseline survey was determined to be 800 households. Assuming 5% non-response rate, 840 households were designed for survey. A total of 28 clusters were allocated equally between the two regions. Consequently, 14 clusters were given for each region and 30 households per cluster allocated for the total sample size of 840 households. However, only a total of 676 households were surveyed. This is because two villages in Assab sub-region found to be irrelevant for the baseline survey as the dwellers were not belong to fishing activities rather they are public employees and traders. In addition, one village in sub-region Central Denkalia was not accessible due to the nomadic nature of living of the inhabitants. The village and the clusters selected are given in the appendix B, table 4.1.

The selection of households has been done by looking on the recent household list at each village administration. If the list less or equal to the required household sample, data were collected from every household otherwise the random walk was used by looking at any corner in the South-Eastern direction of the village to start with the first household interview. The next household interviewed by leaving households equal to the approximate number of sampling interval. The process continued until the required number of households was interviewed.

Since the study dealt with households who are engaged in fishing activities, it is inevitable to exclude those with others main source of livelihood. The sample available for the analysis, consequently, composed of 279 households. However, data is only available for 203 fishing unit households (72.76%) and hence considered in the study. The remaining 27.24% of the cases are those for which data were not taken or one or more individual variables are missed.

4.2.2 Qualitative Sample

Qualitative survey was also conducted through Focused Group Discussion (FGD)[15] and KIIs[16]. The purpose of this survey was to understand the livelihood condition of the coastal communities in-depth. Along this FDP baseline survey, the study also employed qualitative primary data collection from the concerned officials in the MMR, academic researchers, instructors from college of Marine Science and Technology and private consultants using open ended questionnaire and interviews. A moderator (the researcher himself through telephone) channelled the KII discussion to draw explicit concepts, thoughts, and contrasting understanding that has been came-out from the baseline survey and literature review.

4.3 Data analysis Technique

In the study both primary and secondary data was triangulated at the processing and analysis stage using a combination of various data analytical tools. To accomplish the research question, identify the determinants of fish catch, descriptive statistics such as means, percentages and frequency, bi-variate analysis, and OLS multivariate regression technique was used. To investigate determinants of the use of inboard motorized fisheries against the

[15] FGDs were employed to increase the attitude, perception and views of the potential stakeholders on the situation of artisanal fisherfolks.
[16] KIIs targeted at a variety of potential informants like village administrators, MMR branches, fish processing company staff, and knowledgeable community members.

less resourceful and relatively traditional outboard motorized boats, the probit model was used. Discussion and illustrative analysis were provided only for significant variables.

4.4 Model Specification and Rationale

4.4.1 The OLS Model

Factors influence fish catch

Factors that influence the amount of fish catch by the artisanal fisheries were chosen through primary data source, literature review and practical skill while visiting fishery sites and projects and given as follows.

Dependent variable

The issue of either quantity or value of output as appropriate dependent variable in the production function was considered. As in many industries, the relationship between quantities rather than value defined the output of a production function(Ikiara 1999). In fishery of this study, all fish off-loaded at the landing site bought by a parastatal National Fisheries Corporation (NFC). There is no price difference among fishermen that may arise from difference in auction. It is only the size of the catch that matters the performance of the artisanal fisheries as the price is fixed and controlled by the NFC. Furthermore, for the use of the 2010 cross-sectional data, the price of output and all variable and fixed inputs utilized are the same across fisherfolks and vessels. For this reason, the weight of the catch rather than the value chosen as the appropriate dependent variable.

Independent variables

According to Panayotou (1985), fishermen vary in the quantity of fish they catch due to technological differences, input combination, and resources abundance as well as random factor, due to pure luck. Likewise, Olomola (1991) stated that fish catch depends on the fisher's boat type, fishing skill, gear type, resource abundance, and other important variables. However, the precise choice of independent variables differs among studies and is largely valid on data availability, fisheries characteristics and the anticipation to capture the complete scope of inputs (Nguyen 2010). Based on this, we tried to explain the independent variables employed in this analysis.

Fishery resource abundance is considered as a major determinant input in the fishery production function (ibid). He further mentioned that stock abundance is assumed to be constant unless information is accessible for at least two-period data to be included in the analysis. Nevertheless, studies (Campbell 1991, Ikiara 1999, Mwakubo et al. 2007) show that when cross-sectional data are employed or specific location investigation applied, stock size is assumed to be constant and thence excluded from the list of independent variables.

Since fishing technology is not homogeneous but consists of certain methods fishing (Nguyen 2010), the fishing gear and vessel type are crucial to the variations in catch (Ikiara 1999). The survey shows that fishermen uses three fishing techniques, namely, hook and line, gillnet, and mixed gear using Houri and Sambuck boat type. These qualitative descriptions offer the possibility to use dummy variables to capture qualitative difference in fishing technologies (Panayotou 1985).

Further, fisher's characteristics may also explain part of catch variation(Ikiara 1999, Nguyen 2010). They stated, this could be captured from factors, such as age, fishing experience, skipper's education, household size, sex and religions. Educated fisherfolks could have better likelihood of fishing business understanding and able to influence their fishing unit's catches (Akanni 2008). Moreover, Ikiara (1999) argued, skipper's education may influence catch as more educated fishers are likely to be wealthier, more responsive and better planners. Inoni and Oyaide (2007) found skipper's experience as major determinant of catching power in Nigeria and then we expected fishing units with skipper's longer experience are to be relatively more efficient. Sex also determines the likelihood of influencing the catch level while the effect of religions is not clear (Panayotou 1985).

However, in the fisheries under the study, the fishing business is traditionally male dominated. Whereas concerning religion, the artisanal fishing business is traditionally bounded by inhabitants of the coastal area, which are Muslims. Thus, neither sex nor religion was included in the model, though there is a widely held hypothesis, but not tested thoroughly, that Muslims evade long fishing trips (ibid). In addition previous studies shows that(Akanni 2008, Inoni and Oyaide 2007, Mwakubo et al. 2007), household size has mixed effect (both negative and positive) on fish catch.

Other capital utilization, such as access to fuel and ice, and labour utilization in terms of crew size involved in fishing unit considered as common inputs in most previous studies (Nguyen 2010). The bigger the size of crew is, the higher the expected catch given that diminishing returns concept are not violated due to fishing technology constraints, such as gear and vessel (Ikiara 1999). Moreover, more crew could allow processing its operation faster and therefore offer more time for fishing (ibid).

It is also pertinent to consider access to credit, as artisanal fishermen who are by definition face capital constrictions to employ adequate quantities of fishing inputs (Panayotou 1985). Therefore, it is possible to reflect variation in catch owing to access to credit differences. However, data limitation from the baseline survey restricts to identify the type of credit, so as to deal accordingly. Moreover, access to extension agent and training likely to create better tendency to be well informed in the process of fishing and thus difference in catch (Akanni 2008).

The role of fisher cooperative associations through their provision of service to its members could have possible influence on fish catch. We expect, therefore, fishermen who are member of the cooperatives to be relatively more productive. To capture this influence, we used dummy variables as a qualitative response for being membership or not. Non-fishing income, such as crop production, animal husbandry, trade and other livelihood may also reflect variation on the catch. Mwakubo et al. (2007) found non-fishing income to be major determinate of catching power with a negative influence on fish catch in Kenyan coast of lake Victoria.

Model Specification

Given the economic theory and existing literature, the study has identified the catch level per day as the dependent variable, while the factors that affect this catch are the independent variables. The econometric model postulated and employed in this study shows that the amount of fish catch level is determined by the fishing effort, a vector of inputs such as labour, capital, and resources. The description and measurement of the variables are given in appendix B, table 4.2. The general model is a form of:

$$Y = f\left(X_1, X_2, X_3, \ldots X_{16}\right) \qquad (4.1)$$

Where, Y is the average catch level per day given as a function of the independent variables, X's. For functional form expression, we made use of X_{ij} to indicate the variable X_i with the value of the j^{th} observation. The linear regression model assumes that each set of value of K independent variable, there is a distribution of Y_j values with a mean distribution represented by the equation as follows (Wooldridge 2009):

$$E(Y_j) = \alpha + \beta_1 X_{1j} + \beta_2 X_{2j} + \beta_3 X_{3j} + \ldots + \beta_k X_{kj} \qquad (4.2)$$

Where, β_1, β_2, β_3 …, β_k signify coefficients of the X's variables indicating population parameters. The interpretation of β_i represent the expected value of Y due to a unit change in X_i given all other explanatory variables assumed constant. However, qualitative regressor coefficients interpretation is quite different. It is the expected change in the value of Y owing to the variation in dummy variables within the sub-groups relative to their reference (Gujarati 2003). While α is a constant term.

Moreover, Y_J individual observation is assumed to be estimated and determined by an equation with an error term and represented as:

$$Y_j = \alpha + \beta_1 X_{1j} + \beta_2 X_{2j} + \beta_3 X_{3j} + \ldots + \beta_k X_{kj} + \varepsilon_j \qquad (4.3)$$

The Greek epsilon, ε_j, error term represents the value of Y_j deviation from its mean. The error term can be imputed to either the effect on the level of fish catch (Y) from the variables which are not included in the model or a random residual element in the regressand. Since population parameters are not easy to determine directly, their values can be estimated from finite sample size taken from the population. Thus, equation 4.3 which is population linear regression equation can be expressed as sample linear regression model written as follows:

$$Y_j = a + b_1 X_{1j} + b_2 X_{2j} + b_3 X_{3j} + \ldots + b_k X_{kj} + e_j \qquad (4.4)$$

Estimating the sample linear regression function, as the most common method, is to use the OLS regression given that OLS assumptions are satisfied[17].

Therefore, the general model of fish catch per day is a form of:

$$Y_{qty} = \beta_0 + \beta_1\, btt + \beta_2\, grt1 + \beta_3 grt3 + \beta_4\, atth2 + \beta_5 atth3 + \beta_6 expf + \beta_7 crs + \beta_8 age\_hh\_head + \beta_9 hhsize + \beta_{10} lna + \beta_{11} copm + \beta_{12} tgexa + \beta_{13} nfi + \beta_{14} ica + \beta_{15} fua + \beta_{16} mka + e_j$$

4.4.2 The Probit Model

Factors determining the use of in-board motorized fisheries

Factors that influence the adoption and use of inboard motorized fishery boats are chosen through primary data source, literature review and practical skill while visiting fishery sites and projects

Fisher's characteristics

- Education: An educated fisher is more likely to have the ability to perceive and interpret, and thus, adopt relatively better technology much faster than uneducated one (Uaiene et al. 2009).
- Age: Young and middle-aged fisher with a lot of energy assumed to be more willing to adopt new technology than older one, who is risk-averse, conservative and unlikely to try better technologies (Wetengere 2010).
- Fishing experience: Technology adoption and use was often expected to be highly associated with producer's experience(Caffey and Kazmierczak 1994). Number of years in fishing has greater likelihood to understand better technology working mechanism and acquire fishing knowledge and then use it more than those who lack the experience.
- Gender and belief excluded from the model due to the reasons explained in section 4.4.1.

Household resource endowment

- Non-fishing income: Usually, if the expected contribution of income from employing better technology is higher than other sources of livelihood, fishers are more likely to allocate income to better fishing practise (Wetengere 2009). Inversely, better technology adoption is financially demanding, fishers with other sources of income are less likely to adopt and prefer to continue with the existing one (Wetengere 2010).
- Household size: Tiamiyu et al. (2009) argued this variable likely to explicate technology adoption positively as it is responsible to determine

[17] *OLS basic assumptions are available in Gujarat (2003) and Wooldridge (2009).*

the size of labour to be employed and capable to respond to improved technology.

- Credit facilities: Accessibility to credit source could likely to determine the use of better fishing technology (Akanni 2008). Conversely, lack of sufficient accumulated saving by fishermen may prevent them from employing improved fishing technology (Panayotou 1985).

Technology characteristics

- Marketability: Fishers are willing and likely to adopt and use improved practice if production has access to and easily marketable. Distance to fish collection centre or market is presumed to play critical role in the process of better technology adoption (Uaiene et al. 2009). Thus, we use access to market dummy variable to capture distance to fish market.
- Extension: Fisherman access to contact with the extension agents could determine the likelihood of being properly informed about the relevance of better fishing vessels and their probability of using them (Akanni 2008).
- Operational costs: it is the cost of fishing in keeping the operation running (Wetengere 2009). If the expected running cost of Sambuck fisheries is lower than its counterpart Houri, Sambuck fisheries could likely to be adopted.
- Fishery cooperative: Cooperative membership considered because it has usually intended to promote economic and human development of the fishing community (Pasience 2009) and that fisher within the association learn from each other and carry out better fishing technology. Conley and Udry (as cited in Uaiene et al. 2009) argued, network effects are essential for decision making as farmers share and learn information from each other.

Model Specification

To identify determinants of adoption and use of inboard motorized fisheries against the less capable and relatively traditional outboard motorized boats, probit model was employed. Houri and Sambuck are the two main fishing craft. The review explicitly showed that inboard motorized Sambuck fisheries are more preferable for prolonged fishing, distance trips, large in size and more economical relative to outboard Houri. Consequently, the level of fish catch highly varies between these two fishing craft. However, inboard motorization fishing is facing difficulties in terms of adoption and use by the fisherfolks (Pasience 2009). In this model, therefore, we tried to investigate the determinants of inboard motorization fishing technology.

Quite large number of different studies has been investigated the effect of various socio-economic, technological, cultural and political factors on the adoption and use of better technologies (Akanni 2010, Akanni and Akinwumi 2007, Rahji 2003, Uaiene et al. 2009, Wetengere 2010). In many of these adoption process, the dependent variable is constrained to either 0 (not to adopt/use) or 1 (use/adopt) and thus best analysed within a univariate dichotomous model framework using the probit or logit models (ibid).

Consequently, these models have been employed in econometrics applications in the leading journals almost exclusively (Horowitz and Savin 2001).

The basic difference between logit and probit model is the distributional assumption of the error term. Probit assumes standard normal distribution ($\varepsilon \sim$ N(0,1), zero mean and unit variance) while logit, logistic cumulative distribution ($\varepsilon \sim$ N(0,$\pi^2/3$)). Thus, both distributions are symmetrical around zero and have quite similar shapes, except the logistic has fatter tails, and thus the functions of conditional probability are very similar (Horowitz and Savin 2001, Uaiene et al. 2009). The choice over these two models is then, quite similar in terms of the regression result. Whether one uses the probit or logit does not matter, given that the distributions are very similar (Ikiara 1999). Since there is no strict basis for preferring one over the other, one can make a choice based on familiarity and tests (Wetengere 2009). However, Wooldridge (2009) argued, even if the logit and probit models are quite similar in most application and findings, the latter is more popular because economists tend to favour the standard normality assumption of the error term. Final and most realistic as Gujarati (2003) revealed, even if the logit model is simple, the normality assumption is more widely common in empirical analysis. Consequently, we chose the probit model and based on the analytical framework developed, the empirical model specified as follows:

$$ADOPT_1 = \beta_0 + \beta_1\, atth2 + \beta_2\, atth3 + \beta_3 expf + \beta_4\, age\_hh\_head + \beta_5 hhsize + \beta_6 lna + \beta_7 copm + \beta_8 opct + \beta_9 nfi + \beta_{10} mka + \beta_{11} tgexa + \epsilon_i$$

4.5 Conclusion

The study used both primary and secondary data. The dependent and independent variables are identified based on literature review, primary data and previous personal observation. The data both in the processing and analysis stage triangulated through descriptive statistics, bi-variate, linear OLS and probit model. On the one side, basic shortfall of the cross-sectional analysis which is inability to control for unobserved heterogeneity among fisherfolks and on the other side, the small sample size, and consequently, inference to the entire artisanal fishing population would be hard to build. Besides, data limitation restricted the identification of the type of credit so as to consider and include accordingly in the analytical model.

Chapter 5

Result and Discussion

5.1 Introduction

This section presents the data analysis and discussion of the research findings with the view of answering the study's research question. In our methodology, as we mentioned that to scrutinize the factors that influence the fish catch levels, descriptive statistics, bi-variate analysis and the OLS multivariate technique, are given in section 5.2. Section 5.3 then discusses the empirical result in identifying determinants of the use of inboard motorized fisheries against the less capable outboard boats. Finally, section 5.4 closes by showing the core findings to address the research problem and tackle constraints.

5.2 Determinants of Fish Catch Level

5.2.1 Descriptive Statistics

Mean, standard deviation, frequency and percentages of key variables

The artisanal household fishery characteristics presented in appendix C, table 5.1 and were discussed included the fishermen's age, boat type, catch, educational level, fishing experience, household size etc. In the table, summary of frequency, means and some measure of dispersion, minimum and maximum values, and standard deviation are given.

The level of fish catch ranged between 17.77 - 140.55kg per day. For Houri, two-third (66.94%) of the fisheries had a maximum of 60kg with average of 52.56kg, while only 16.46% of the Sambuck operators had a maximum catch level of 60kg with average of 88.58kg (table 5.5). Thus, the catch of fishers practising Houri are rather very low compared to catch capacity of inboard motorized diesel engines (Sambuck), capable of covering long distance and considered more economical.

The age of the fishers in the sampled survey ranges from a minimum of 32 to a maximum of 75 years, with mean of 56. The average age of the fishers practising Houri fisheries was 60 years while it was 49 years for Sambuck operators. About 90.64% of those practising Houri and 79.74% of Sambuck operators was 41 years or older. This suggests that the sector is working with old aged fishers as opposed to the labour intensive nature of the business which demands young people who are more efficient and physically strong.

A relatively large household size was found, average size of 6 persons per household with 41.85% of the households have between 7 and 9 family size. Given the labour intensive nature of the fishery sector, large household size may contribute to the labour demand, mainly in post-fishing activities (Inoni and Oyaide 2007). Conversely Ong'ang'a (as quoted in Mwakubo et al. 2007:525) argued, "Large household size imply increased family demands, leading fishermen to belong to the low-income bracket". While, fishers in the study area argued the traditional believe of polygamy is the reason for large family.

The level of educational attainment averages about 1.1 years, suggesting that majority (71.43%) of the fishermen has no schooling at all. Primary schooling is the maximum level of education for about 95.57% of the fishermen (table 5.8). Mwakubo et al. (2007) stated, since education is not the kind of essential talent in fishing, it is not expected to be key determinant of catch. Conversely, according to Inoni and Oyaide (2007), lack of education provide significant limitations and hence expected to affect catch level positively.

Fishing experience ranged between 8 to 45 years, with mean of 20 years. In fact, 86.21% fished for a maximum of 25 years. Majority (62.07%) of Houri and 59.5% of Sambuck fishers have been in fishing business for a maximum of 20 years and minimum of 21 years respectively (table 5.9). The distribution indicates that fishers are old in the business. Artisanal fishers require sufficient experience to operate in deeper waters where resource abundance is greater (ibid). Since experience helps the fortune and deeds of fishers, the more experience the fisher's entails, higher fish catch is expected (Olomola 1991). Whereas fishing crew size ranged from 3 to 10, with 5.69 mean value. More than three-quarter (83.87%) of Houri fishers had a maximum of 5 crew and mean of 4.46, while 87.34% of Sambuck fishers had minimum of 8 crew with mean of 7.62 (table 5.10). This indicates that fishing is highly labour intensive business.

Currently, hook and line is the most prevalent gear for Sambuck fisheries, with 70.89% of the fishing units exclusively practising this technology. While 20.25% used combined gear technology. Majority (52.42%) of Houri operators accounted for a combination of gillnet, and hook and line capture technology, while 45.16% of their catch came from gillnet gear alone (table 5.11).

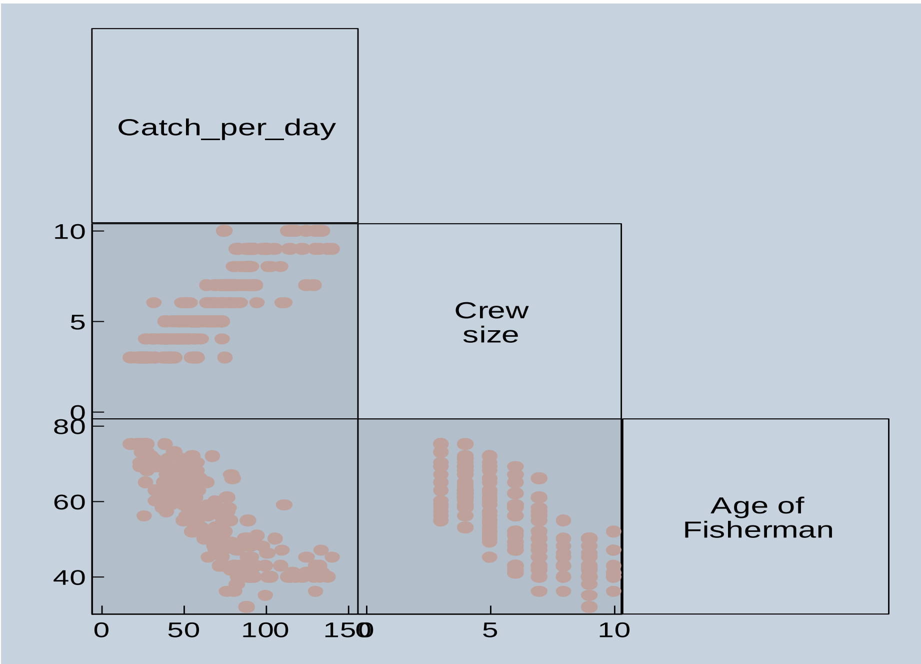
The interpretation of the dummy variables is rather different. For instance, access to credit facility is given as 0.24, indicating that a proportion of the sample that had access to sources of funds in terms of cash, boat, spare parts and nets for the fisherfolks (table 5.1). Similarly, the mean of access to ice, fuel and market is given at 0.45, 0.57 and 0.28 respectively. This shows that only 28% of the fishers had access to market, while about two-quarter had access to ice and fuel. This indicates that, marketing fishery products is a serious problem mainly for the Southern part of the Red Sea as the fishermen discontented with fish processing plant (the only available market) which is very far from most fishing villages and lacks transporting facilities. In addition, table 5.1 shows, nearly more than half of the fishermen are members of the cooperative and about 45% had access to fishing related training. It also explains, majority of the fishers (66%), depends entirely on fishing for their livelihood. Only 34% had additional income from other sources, such as farming, animal husbandry, or trading.

5.2.2 Bi-variate Analysis

In order to obtain all-rounded insight of the relationship between catch level per day and the independent variables, we employed analysis of variance (ANOVA), correlation matrix and scatter plot. Given the word limit, only the summary of the results from the comprehensive bi-variate analysis were presented here.

The correlation matrix between crew size and catch level indicates a positive relationship and the association between age of fisher and catch is negative and strong. The former had 0.87 and the later -0.82 of correlation coefficient and their matrix of scatter plots was given below in figure 5.1. The figure shows, those who had large crew size associated with high catch level. In contrast, fisheries with old aged fishers seem to have low catch levels.

Figure 5.1 Matrix of scatter plots for catch, crew size and fisher's age



Source: Author's own computation from the baseline survey

The catch level relationship with vessel type and fishing gears can be better clarified using ANOVA technique. Summaries of the results of the ANOVA and the correlation matrix are presented in appendix C, table 5.2. From this technique, there is strong evidence that the average catch varies among the type of gears and boats employed. The analysis indicates that, on average those who employed hook and line, and gillnet had higher and lower catch respectively. Similarly, there is significant difference between the type of boat used and average catch levels, fishers with Sambuck boat harvest more relative to Houri operators.

The correlation matrix for access to ice and training showed a strong relationship with the catch level. These variables found to be significant at 5%. Similarly, the ANOVA with a null-hypothesis that there is no difference in the average catch level of those who had access to training or ice and those who had limited or no access is rejected. Consequently, both relationship analyses showed a significant difference between access to these variables and average level of catch.

Other dummy variables, access to loan, cooperative membership and non-fishing income showed weak or no association with catch. Nevertheless, the ANOVA technique seems to indicate significant difference in the average level of catch and access to these variables. Access to loan and cooperative membership found to be negatively associated with catch which is not theoretically supported but weak correlation. On the other hand, in spite of the weak negative association between catch and non-fishing income, the relationship is theoretically supported. Unexpectedly, neither the ANOVA nor the correlation matrix showed any sign of relationship between the catch level and marketing availability as well as access to fuel.

5.2.3 Multivariate Regression Analysis

Preliminary Analysis

Test for Heteroscedasticity

Since we used cross-sectional data, the test has been employed in order to avoid the bias of the variance of the estimated parameter and address the problem of independently and identically distributed error term. This has been made using the Breusch-Pagan /Cook-Weisberg test, the null hypothesis with constant error variances versus the alternative error variance are multiplicative function of one or more variables (Gujarati 2003). The result of the test shows in table 5.12, a chi-square value was large with a p-value of 0.0000, indicating the presence of heteroscedasticity. Therefore, the null hypothesis that the error variance is constant or identically distributed is rejected. To shed additional light on heteroscedasticity test, the White's General test is also employed. Table 5.13 shows the White's test for a null hypothesis that the error variances are equal. The result confirms that the error variance is not constant. Consequently, we used the heteroscedasticity-robust standard error to estimates the reasonably accurate test statistics.

Multicollinearity

The concept of multicollinearity was also taken in to account. Multicollinearity is a linear relationship among two or more explanatory variables of a regression model (Wooldridge 2009). The test has been done using the variance inflating factor (VIF) which shows how the presence of multicollinearity inflates the variance of an estimator (Gujarati 2003). According to him, if a variable with VIF exceed 10 or its tolerance closer to zero, there is an indication for collinearity. Subsequently, table 5.14 indicates the highest VIF is 5.96 or tolerance, 0.1758. The result inferred the absence of collinearity among the explanatory variables.

To incorporate the VIF result with alternative test, we used the auxiliary regressions test. The rule of thumb of this test explains that if the overall R-squared is less than the R-squared obtained from auxiliary regression, regressors might be plagued with the multicollinearity problem (ibid). Table 5.15 suggested that, no auxiliary regression R-square found to be greater than the overall R-squared (0.86 from table 5.3). Thus, multicollinearity is not a serious problem. Alternatively, since the calculated tolerance from this table is not closer to zero, it seems that no evidence on the presence of multicollinearity.

To shed extra light on the issue of multicollinearity, we examined the correlation among all the independent variables to find out if one or more variables are strongly related with other variables (table 5.16). Based on Gujarati (2003), the estimated correlation matrix in the table indicates the absence of any variable with a pair-wise correlation in excess of 0.8, and then multicollinearity problem is not showed. In-sum, there is no exact procedure to follow for multicollinearity detection rather all are indicators and belongs to the nature of 'fishing expedition' (ibid). The VIF test, for instance, may be necessary but not sufficient condition, because a higher VIF is not necessarily to give inflated variance as it is also depends on the error variance and total sum of squares(Wooldridge 2009).

Estimation result

Using the model developed in section 4.4.1, and the econometric analysis of the parameter investigated, we could link boat type, fishing experience, crew size, access to ice, and household size to increase fish catch level (appendix C, table 5.3). In contrast, age of the fishers, non-fishing income, and access to credit facilities are linked to reduce catch.

Boat type has a positive and significant effect on fish catch, indicating that Sambuck used to be relatively very important. This is due to the fact that the engine type and capacity of the boat greatly facilitates its operation as it is capable of covering long distance, far better carrying capacity and more economical. In contrast, the physical and technological attributes of Houri, such as engine type and capacity, fishing distance limit, limited carrying capacity deters its fishing operation. The result pursuant with the findings by Ikiara (1999) who indicates dummy variables employed to capture difference in vessel mode of propulsion were statistically significant. Fishing boats, therefore, those are technologically restricted to inshore fishery harvest less and thus vessel mode of propulsion significantly explains the catch size.

Household size also exerted a positive impact on the level fish catch. First, large household size might imply higher subsistence needs and hence, fishing effort has to be increased to meet financial responsibility of their families (Mwakubo et al. 2007). Second, since artisanal fishing is labour intensive, family members may become part of significant share of the labour demand (Inoni and Oyaide 2007). This result is concurred with Inoni and Oyaide (2007), who showed that household size, is significant in explaining catch level.

The crew size was also found to be positive and highly statistically significant determinant of fish catch. Almeida et al. (2001) and Inoni and Oyaide (2007) found labour to exert fundamental contribution to artisanal fish production in a study of the Brazilian Lower Amazon and Agro-Ecological zone of Delta state of Nigeria respectively. The result suggests as the size of crew size increases, fish catch will increase, other things being equal until an optimal level of crew size is reached.

In contrast, age of the fishers linked negatively and statistically significant effect on catch. This is consistent with results obtained by Panayotou (1985). Akanni (2008) asserted, younger people have the capability to fish more than older fishers. Similarly, Olomola (1991) argued, as fishers getting older, performance deteriorated and hence the level of fish catches. The descriptive statistics showed that fishers are very old aged in the sector. This could be due to the restrictions imposed on young fishermen who are below 50 years of age to provide 50,000 Nakfa before any fishing expedition as a guarantee to be returned (Pasience 2009). The KII further shed light on age of fishermen and its effect. The source indicates that directives to restrict fishermen below the age of 45 years to deposit Eritrean Nakfa100,000 as a guarantee for two weeks albeit to be returned might result in limiting young fisher from fishing activities and thence abort fishing.

As Squires et al. (2003:16) stated "fishing experience of captains often provides better knowledge about the location of fish, weather patterns, currents and tides, bottom conditions, and how to best catch the fish". In support of this claim the study found, experience provides a positive and highly statistically significant effect on catch level. The more experience the fishers entail, higher competence of fishing at a particular time. This implies greater experience increases efficiency. This observation is agreed with the finding by Ikiara (1999) that a captain who has a year more experiences than other fishing unit captains makes a better catch.

Dummy variable used to capture access to ice is statistically significant, implying that having access to ice is an important factor that affects positively the catch level. Ice is one of the most important inputs in the fishery industry, particularly in the Eritrean artisanal fishery. Since the fishing practice strongly demands enough ice to allow fishers to sail further offshore and stay longer days rather than bound to fishing operations on daily basis like Kenya's Lake Victoria and Nigeria's Delta State fishers. Artisanal fishers as described by the KII uses ice both in the course of fishing and handling, processing and transporting either in the form of block or flake ice, a total of 2:1kg of ice-to-fish ration.

Non-fishing income, i.e. income from sources other than fishing has a negative and statistically significant effect on fish catch. This might imply that the existence of alternative sources of livelihood is a key factor in supporting fishery resources under-utilization. This is similar to the finding by Mwakubo et al. (2007) that the availability of non-fishing income has a negative and significant effect on fish catch. As KII suggests, due to the nature of the surveyed regions like poor soil quality and erratic rainfall, agriculture is unreliable and leaving the only other income sources such as occasional sell of livestock, village shop-keeping and credit among them. These might suggest that artisanal fishers almost entirely depend on marine resources.

Similarly, market availability, access to credit and cooperatives membership negatively influence catch level, which is not theoretically supported. However, only access to credit facilities had statistically significant effect. A close analysis of the data shows that majority (61.6%) of fishers who had access to loan are with a minimum of 60 years old and this limits the fishing capability, consequently low fish catch level. As already mentioned before, fisher's age and the level of fish catch are inversely related irrespective of the fishing facilities they are equipped. According to KII sources, the fishery loan system is highly frustrated by the loan repayment performance. The status of loan repayment rate is very low, only 23.37%, the worst case for Southern Red Sea Region marked at 11-13% (Pasience 2009). This entails that there is compelling evidence towards inefficient utilization of the loan.

Further, the interview indicates fishers' cooperatives are poorly organized, causing fishers to lose their faith in their association and thence affects their fishing business. The survey indicates majority (58.62) of the fishermen are registered as member of their cooperatives in the belief that the system would help to get access to supportive facilities, such as lucrative marketing possibilities, training opportunities, access to necessary fishing facilities and spare parts on credit basis. Nonetheless, cooperatives play no significant role at all (KII 2011).

Marketing fishery products is a serious problem. According to the KII and fishing operators interviewed there is no market provided to their fish, all is delivered to fish processing plant at the price set by the government which is managed by the NFC. Further the informants indicate, fishers are not satisfied with the fixed price as it does not allow them to cover their basic expenses. The source also disclosed that due to this poor marketing system, there is a temptation to use these boats to smuggle illegally to and from Yemen in search of better market and fishing facilities. This unsolicited component of fishing activity may indicate to recognize the effect of unreported catch in which actual harvest could be underestimated. This investigation might be reflected on the reliability of the data employed in the study. However, the result indicate that the average catch level of those who have access to market and have marketing problem is almost the same.

Moreover, the other variables, fishing gear type, fisherman education, access to fuel and training found to be statistically insignificant and consequently unlikely to create differences in terms of variation of fish catch. For instance, the level of education is not likely to appear to be major determinant in terms of the fish catch level variation in the West coast of the Malaysian Gill-Net artisanal fishery (Squires et al. 2003). Conversely, education may have effect on fish catch as it helps to understand fishing practice and technology and more likely to use best fishing mechanism (Mwakubo et al. 2007). Given these inconclusive evidence, we found that the level of fish catch is indifferent among fishers who have no schooling, primary, and junior and secondary education.

Table 5.3 also shows that F-ratio of 68.17 was significant at 0.01 significance levels. This supports the hypothesis that the entire model is statistically significant. A combination of those selected independent variables had joint impact on fish catch level in the study area. The beta weight ranged from -0.92 to 1.42. This result implies that out of the sixteen independent variables considered in the model, the fishing boat type (if fishers employ Sambuck relative to Houri boats) with the highest value of 1.42 is the most important variable in fishery production function. This is not surprising because irrespective of the MSY, development practices and efforts the variation in fish catch level is mainly explained by the type of boat fishers employed in their fishing operations.

5.3 Determinants of Fishing Technology, Boat

5.3.1 Probit Model Analysis

The probit model was used to identify determinants of the fishing technology and presented in appendix C, table 5.4. Since not much obtained from the probit parameter, except interpretation from the sign, marginal values from this probit model were calculated (Wetengere 2010). Access to credit facilities, operational costs, non-fishing income, and cooperative membership were found to be significant determinant of the adoption and use of inboard engine motorized fishing technology.

Availability of credit facilities was positively related with likelihood of adopting fishing technology. The sign was consistent with prior expectations. This implies fishers who had access to credit facilities for the use of artisanal fisherfolks were more likely to increase the adoption and use of inboard engine fishery by 52% than those who had not have such access. This is similar to the finding by those of Akanni (2007) and Uaiene et al. (2009), that credit facilities were likely to enable fisheries to acquire technology that had capable to realise better output.

Operational cost was also significant in explaining the adoption of in-board engine fishery. The study showed that, fishers' probability to adopt a technology could also increase, if adopting better technology promises greater cost cutback in keeping the operation running than using the existing practice. Accordingly, this variable found 59% more likely to increase the use of Sambuck boats. It was also noted that the sign of this variable concurred with prior expectations. In addition, appendix C, table 5.17 indicates the cost breakdown of keeping the fishing business running supports adoption and use of Sambuck boats. Accordingly, the cost of fishing with Houri was relatively extremely high, 7.1Nakfa per kilogram. This is due to the use of petrol (39% of the total cost) and the lower production capacity (average about 325kg) which contributes to high operational cost of Houri as compared to Sambuck fisheries, 4.98Nakfa.

Membership to fishery cooperatives was found to be positively related with the probability of adopting inboard engine motorized fisheries. This suggests that, if a fisherman belongs to membership in an association, the probability of adopting better fishing technology (Sambuck) increased by 17%. The sign was agreed with prior expectations and similar to those obtained by Uaiene et al. (2009), showed that membership in association appear to be the most influential determinant of technology adoption and use.

Non-fishing income was negatively related to the likelihood of adopting and use of inboard fishing technology. This entails that as income from other sources increased, the probability to adopt and use Sambuck fishing technology decreased and fishers preferred to continue with the less capable and relatively traditional fishing technology, Houri fishing vessels.

Fisherfolks who had other income sources 19% less likely to adopt and use Sambuck fishing technology. This result is consistent with the findings by Wetengere (2009) who showed that wealthier fish farmers were unlikely to adopt better fish farming technology than poor farmers.

The effect of the other variables, fisher's age, household size, fishing experience, marketability and access to training and extension agent were not significant in the likelihood of adopting and use of inboard motorized fishery. Access to training and extension agent, for instance, expected to have significant effect on the adoption and use of Sambuck fishing technology. This is because fishers are likely to be more informed on the relevance of better fishing technology if they have higher access to extension personnel (Akanni 2008). Similarly, fisher's experience was expected to influence the likelihood of fishing technology adoption and use. Technology adoption and use studies showed that let alone own experience, neighbours' experience creates influence on probability of adopting better technology that could maintain higher output (Foster and Rosenzweig 1995). These and other apparently contrasting findings, therefore, entail further study on the topic. However, Akanni and Akinwumi (2007) for instance found that fisher's experience was not significant on the probability of adoption and use modern fishing technology.

5.4 Core Findings

One of the major factors obstructing artisanal fisheries production is the limited carrying capacity and fishing boats power. There is significance difference between the two types of boats investigated. The descriptive analysis showed outboard motorized fishery, Houri, had very low catch level relative to Sambuck. Similarly, the correlation coefficient and the ANOVA techniques concurred with the statistical significant difference between the types of boat used. The econometrics result also indicates Sambuck fisheries had positively and highly significant influence on fish catch levels relative to Houri. Further, the standardized regression coefficient, beta, has shown the boat type is the most important variable in the fishery production function. All these evidence supports that means of boat propulsion significantly explain the variation in artisanal fishery catch. Given this result, the study confirmed the relevance of adoption and use of inboard fishery to increase and maintain higher catch level. Hence, access to credit, cooperative membership and operational costs found to influence towards the adoption and use of better fishing technology.

Provision of loan system is one of the instruments for improving fish catch efficiency. In the study, about quarter of the fishers had access to loans from MMR. Nevertheless, this variable was found negatively and statistically significant effect on catch level. Theories and experience of Asian countries suggest that loan finance from the government as interventions to enhance the wellbeing of the fishermen have had achieved success in the sector (Panayotou 1985). However, we found that this is not the case in Eritrea. A close look of the data suggested, majority of the fishers who had access to loan were old aged. Consequently, they are less capable to reinvest in their fishing operations or increase fishing efforts rather might consume it or use for other less labours business activities. This observation is similar to the findings by Pasience (2009).

From 1994-2006 about 22,336,117.59Nakfa were disbursed and the repayment was only about 22.95% (MMR 2007). The KII suggested that this is mainly due to inefficient loan utilization and low fish catch. Further, it is also indicated by anecdotal evidence that alternative use of these boats are common practices among fisherfolks, such as smuggling goods to and from neighbouring countries. All these lead us to conclude that loans facilities were not properly utilized. This assertion agreed with Lawson (1984) which stated, many schemes of developing artisanal fisheries were becoming ineffective not due to shortage of loan-able funds rather by the lack of an integrated fishery development plan.

The study showed that 59% of the fishermen are member of cooperatives. Usually, cooperatives were created with the objectives of providing fishing inputs, securing highest possible catch price, credit assistance, training opportunities and enhance efficiency (Ikiara 1999). This being the fact, this variable was found to be statistically insignificant. With the exception of very few cases (9.34%), the KII and fishermen indicated that cooperative societies provided no support for their members. However, yet they deducted a share of fishers' catch sales as commission and contribution. This observation is similar to Ikiara (1999), who showed that cooperatives, except deducting 10% of their member's catches provided no services at all. Hence, cooperative societies in the study area have played insignificant or no role at all except looking for their charges. Moreover, 72.41% of fishermen had severe marketing problems while most of them (66%) depend entirely on fishing.

Nevertheless, the probit analysis showed cooperative societies and loan facilities enhance the likelihood of adopting better fishing technologies. This clearly indicates that loan facility and cooperatives societies were not efficient in enhancing the production capacity rather only obliging fishers acquired better fishing boats. Thus, it seems that alternative usages of these boats and operational credits are negatively affecting the artisanal fish production.

Fisher's age was negatively and significantly related to fish catch. This elucidates that younger fishers are more likely to be productive. This might be because older fishers find it hard to deal with the stress of fishing expedition (Panayotou 1985). The distribution of age suggested fishermen are old in the business. The study also showed fishing restrictions on young fishermen limits access to the fishing business and eventually opted to abort fishing. Consequently, the sector plagued with acute problem of young and productive fishers.

Crew size was also found to be the most important factors that affect catch. Having more crew can facilitate the fishing operations. Hiring more crew can help fishers to undertake more trips per month and thus increase catch level. Increasing crew size likely to provide positive marginal product given that the vessel size and capture technology constraints are not become binding to additional labour (Ikiara 1999). Thus, the type of vessel and the extra cost of hiring a crew required further study. Hiring more crew may not be feasible alternative if they are unskilled. However, fishers in the study area are living along the coastline and their entire livelihood depends upon fishery. As a result their fishing experience significantly affects the catch level rather than educational attainment. Even some of them know the abundance and location of fish type.

5.5 Conclusion

The result and discussion of the research topic triangulated using various data analytical tool. Result elucidates positive and significant association between boat type, crew size, fishing experience, household size, access to ice and artisanal fishery catch. Whereas access to credit, fisher's age and non-fishing income are linked to reduce fish catch. The investigation also showed the means of boat propulsion significantly explain fish catch as we found the type of boat is the most important factors in fishery production function. Subsequently, the study confirmed the relevance of adopting and use of in-board fishery to boost scanty artisanal production.

Even though the probability of adopting inboard fishery positively linked with credit, cooperatives and operational cost, fish catch is frustrated by the loan finance from MMR. Despite the fact that majority (66%) depend entirely on fishing and 72.41% had marketing problem, cooperatives found to play insignificant role. Besides, fishing restrictions on young fishers plagued the sector with acute problem of young and productive fishers. Crew size also can contribute a positive marginal catch until an optimal level of crew size is reached.

Chapter 6

Conclusions

Encapsulating appropriate instruments that may enhance artisanal fish catch levels is one of the most intractable challenges in developing countries. A growing number of studies have demonstrated the use of qualitative data in identifying the potential barriers of artisanal fisheries production more generally. Using a cross-sectional data as well as qualitative aspect of the data, the study fills the gap of quite little investigations in identifying the determinants of artisanal fish catch.

Despite the resource potential, the actual Eritrean artisanal fishery production is scanty. The under-exploitation of the resource could either potentially increase to at least 40,000MT or a tenfold increase of the current production is vital. These facts have motivated the study to scrutinize the factors that are responsible for determinants of the fish catch levels in Eritrean artisanal fishery. Further, the paper also investigated the determinants of inboard motorized fishing technology owing to the fact that enhancing harvest and maintaining higher catch requires more versatile fishing boats.

The data both in the processing and analysis stage triangulated using descriptive statistics, bi-variate analysis, linear OLS and probit model. Moreover, to enrich the findings of the topic, qualitative data was incorporated at each steps of the analysis process. To address estimation of reliable and stable model, extensive investigations on preliminary tests have been conducted. The findings elucidated positive and significant link between boat type, crew size, fishing experience, household size, access to ice and artisanal fishery catch. Whereas access to credit, fisher's age and non-fishing income are connected to reduce fish catch.

The means of boat propulsion highly and significantly explicated fish catch. Houri fishing units tend to harvest less fish irrespective of the capture technology they employed as technological impediments restrict them to coastal fishing. We found that the type of boat is one of the most important factors in fishery production function. Subsequently, the study confirmed the relevance of adopting and use of inboard fishery to boost scanty artisanal production. We also found that loans facilities were not efficiently utilized. A close look of the data suggested, majority of the fishers who had accessed the loan were old aged and thus less capable to reinvest or increase fishing efforts. Further, the anecdotal evidence showed that alternative use of fishing boats is common practices among fisherfolks. As a result the status of loan repayment is highly frustrated. Although majority of the fishers having marketing problems while most of them depend on fishing, cooperative societies was found to play insignificant role.

Corollary from the significant and negative effect of fisher's age on fish catch levels as well as restriction imposed on young fishers, the study found that the artisanal fisheries plagued with acute problem of young and productive fishers. On the other hand, until an optimal size is reached, hiring more crew can help fishers to undertake more trips and thus increase catch levels. Further, fishing experience rather than fisher's education significantly explains fish catch level. It seems that the education is not the kind of expertise required for fishing practise rather the fishing experience likely to provide better knowledge of fishing expedition. Owing to their entire livelihood associated with the sea, some of the fishers are well informed of weather pattern, location and type of the resources.

The probit analysis pointed membership in cooperatives, operational cost, and access to credit was found to be likely to change the probability of adoption and use of inboard engine fishing technology. Apparently loan facility and cooperatives societies were not efficient in enhancing the production capacity rather only obliging fishers to acquire better fishing boats. Thus, it seems that alternative usages of these boats and operational credits are negatively affecting the artisanal fish production.

Owing to the foregoing, the study suggested the introduction of more inboard motorized fisheries, encouraging the youth to engage in the sector, organizing efficient loan schemes based on clear understanding of the socio-economic conditions and evoking for well-organized cooperatives that could enable to enhance harvest and maintain a higher catch levels towards the yearly potential yield.

As to the conclusion of further work, apparently there are issues that the study draws attention to and that we did not address empirically. Data limitation on access to credit facilities for instance restricts to identify the type of loan so as to treat them accordingly in our model. Moreover, given the basic shortfalls of cross-sectional data which is the inability to control for unobserved heterogeneity and the small sample size, inference to the entire artisanal fishing population may not be valid. These are areas that require further research and some of these worries could be addressed when the next FDP survey is launched.

Appendices

Appendix A

Table 3.1: Evolution of Marine Resource Landings in Eritrea in '000 MT (1954 - 1983)

Species	54/55	62/63	63/64	64/65	65/66	66/67	67/68	68/69	69/70	70/71	71/72	72/73	73/74	74/75	75/76	76/77	77/78	83/84
Pelagic	25.0	6.7	7.0	16.3	19.7	17.9	6.8	9.0	13.0	19.0	11.0	2.0	3.5	2.0	0.25	-	-	n/a
Demersal	n/a	1.6	1.3	1.2	1.3	1.2	1.2	1.5	0.1	1.2	1.2	1.0	0.6	0.4	0.6	0.15	0.15	n/a
Sharks	n/a	n/a	n/a	n/a	1.1	1.3	5.5	1.9	1.5	2.3	1.1	0.4	0.5	0.03	0.1	0.01	-	n/a
Lobster	n/a	n/a	n/a	n/a	0.01	-	-	0.1	0.08	0.03	0.03	-	-	-	0.02	-	-	n/a
Shells	0.3	0.2	0.1	0.2	0.15	0.2	0.2	1.2	0.4	0.4	0.5	0.3	0.3	-	-	0.004	-	n/a
Totals	25.3	8.5	8.4	17.7	22.26	20.6	13.7	13.7	15.0	22.9	13.8	3.7	4.9	2.4	0.97	0.16	0.15	n/a

Source: Grofit (1971)

Appendix B

Table 4.1: Clusters/Villages selected for the baseline survey

Coastal Region	Sub-region	Village	Cluster
Northern	Massawa	Emberemi, Hirghigho, Kebabi 03, Kebabi 02, Kebabi 01	5
	Ghelaelo	Ghelaelo, Daguda, Marsa fatuma	3
	Foro	Zula, Asur, Erafaile, Gelbabo	4
	Dahlak	Dahlak kebir, Dasko	2
Southern	Central Denkalia	Eddi, Kerrum**	2
	Southern Denkalia	Rahaita, Berasoulie, Beilul	3
	Assab	Menkaekae, Shekayto, Bilenkoma*, **, Asebuy*, **	6
	Araeta	Tio*, Sahil	3
Total	8	25	28

- Source: Author's own computation from the baseline survey
- *two clusters
- ** Villages/clusters were not employed

Table 4.2: Description and Measurement of Variables

Variables	Description	Measurement
Y_{qty}	Quantity of fish catch per day	Kg
hhsize	Household size of respondents	Number
atth	Level of formal education attended by fishermen	Number of years in formal schooling. athh1=no education, atth2=primary; otherwise atth3
expf	Fishing experience	Number of years in fishing
copm	Member of cooperatives	Dummy: yes=1; otherwise 0
lna	Access to Loan	Dummy: yes=1; otherwise 0
nfi	Non-fishing income, i.e., income from sources other than fishing	Dummy: yes=1; otherwise 0
age_hh_head	Age of fisherman	Years
fua	Access to fuel	Dummy: yes=1; otherwise 0
ica	Access to Ice	Dummy: yes=1; otherwise 0
mka	Market availability	Dummy: yes=1; otherwise 0
tgexa	Access to training and extension agent	Dummy: yes=1; otherwise 0
crs	Number of crew	Number
btt	Type of boat or vessel	Type of boat: 1=Sambucks ,0=Houris
grt	Type of gear	1=Hook and Line, 2= Gillnet, 3= Mixed

Appendix C

Table 5.1: Descriptive Statistics (Sample Size=203)

Variable	Mean	Standard Deviation	Min	Max
age_hh_head	55.96552	10.63125	32	75
grt1	0.35468			
grt2	0.295567			
grt3	0.349754			
hhsize	6.211823	2.714001	1	12
atth1	0.7192118			
atth2	0.2413793			
atth3	0.044335			
expf	19.95567	6.68625	8	45
crs	5.689655	2.06029	3	10
yqty	66.57711	27.66459	17.77	140.54
btt	0.389163			
lna	0.2364532			
nfi	0.3399015			
tgexa	0.448276			
copm	0.5862069			
ica	0.4482759			
fua	0.566503			
mka	0.2758621			

Source: Author's own computation from the baseline survey

Table 5.2: Summaries of ANOVA and Correlation coefficients for the relationship between catch per day and the independent variables

Variables	Correlation Coefficients	Analysis of Variance F-Value	Sig.
Type of boat	0.8964*	136.79	0.0000
Type of gear		65.79	0.0000
Gillnets	0.5436*		
Hook and Line	-0.5402*		
Mixed gear	-0.0285		
Level of formal education		28.43	0.0000
No formal education	-0.7441*		
Primary	0.6386*		
Junior and Secondary	0.2742*		
Fishing experience	0.4927*		
Number of crew	0.8666*		
Age of fisherman	-0.8236*		
Household size of fisherman	0.6661*		
Access to loan	-0.3817*	34.28	0.0000
Cooperatives membership	-0.2766*	16.65	0.0001
Access to training and extension agent	0.7180*	213.91	0.0000
Non-fishing income	-0.5756*	99.57	0.0000
Access to ice	0.7564*	268.70	0.0000

Access to fuel	0.0806	1.32	0.2528
Market availability	0.0812	1.34	0.2492

- Source: Author's own computation from the baseline survey
- * significant at 5%

Table 5.3: Regression result on the determinants of Catch in Artisanal Fishing

Variables	Coefficients	Beta[18]	t-statistic
Type of boat (Reference: Houri)			
Sambucks	15.663*** (2.512)	1.42	6.32
Type of gear (Reference: Gillnets)			
Hook and Line	1.936 (2.165)	0.15	0.89
Mixed	2.613 (1.724)	0.16	1.52
Level of formal education attended by fishermen (Reference: no education)			
Primary	5.539 (3.395)	0.68	1.63
Junior and Secondary	5.475 (4.756)	0.94	1.15
Fishing experience	0.438*** (0.149)	0.01	2.94
Number of crew	4.525*** (1.096)	0.18	4.13
Age of fisherman	-0.429** (0.156)	-0.01	-2.75
Household size of respondents	1.125*** (0.426)	0.02	2.64
Access to Loan	-6.328*** (1.930)	-0.10	-3.28
Cooperatives membership	-2.810 (1.906)	-0.92	-1.47
Access to training extension agent	0.899 (2.229)	0.16	0.40
Non-fishing income	-4.880** (2.345)	-0.41	-2.08
Access to Ice	4.773** (2.223)	0.38	2.15
Access to fuel	-1.614 (1.609)	-0.09	-1.00
Market availability	-1.675 (2.036)	-0.12	-0.82
Constant	47.329 (12.025)	-	3.94
Observations	203		
R-squared	0.86		
F-ration/value	68.17***		

- Source: Author's own computation from the baseline survey.
- Robust Standard errors in parentheses
- * significant at 10%; ** significant at 5%; *** significant at 1%

[18] Calculating standardized regression coefficients can be found in Journal of American statistics, such as Johan Bring (1994), How to Standardized Regression.

Table 5.4: Estimated Marginal Effects of factors influencing adoption and use of In-board Motorized Fishing Technology

Variables	Coefficients	z-statistic
Level of formal education attended by fishermen (Reference: no education)		
***Primary**	0.028691 (0.15879)	0.18
***Junior and Secondary**	-0.0398738 (0.23591)	-0.17
Fishing experience	0.0051344 (0.0059)	0.87
Age of fisherman	-0.0096095 (0.00783)	-1.23
Household size of respondents	0.0230007 (0.01851)	1.24
***Access to Loan**	0.517011 *** (0.10196)	5.07
***Cooperatives membership**	0.1670519 * (0.08782)	1.90
***Operational Cost[19]**	0.5865103*** (0.10743)	5.46
***Non-fishing income**	-0.1904953 * (0.115)	-1.66
***Market availability**	0.0926587 (0.09923)	0.93
***Access to training and extension agent**	0.0269341 (0.13859)	0.19
Observations	203	

- Source: Author's own computation from the baseline survey
- Standard errors in parentheses
- * significant at 10%; ** significant at 5%; *** significant at 1%
- (*) dy/dx is for discrete change of dummy variable from 0 to 1

Table 5.5: Distribution of Artisanal Fisherfolks according to their Fish Catches per day

Interval	Entire study		Out-board Fisheries		In-board Fisheries	
	Freq.	%	Freq.	%	Freq.	%
< 20	1	0.49	1	0.81	0	0.00
21 – 40	37	18.23	35	28.23	2	2.53
41 – 60	58	28.57	47	37.90	11	13.92
61 – 80	52	25.62	34	27.42	18	22.78
81 – 100	30	14.78	6	4.84	24	30.38
> 100	25	12.32	1	0.81	24	30.38
	203	100	124	100	79	100
Mean	66.58		52.56		88.58	

[19] If operational cost of Sambuck is ranked lower=1, otherwise=0

Table 5.6: Distribution of Artisanal Fisherfolks according to their Ages

Intervals	Entire study		Out-board Fisheries		In-board Fisheries	
	Freq.	%	Freq.	%	Freq.	%
21/32 – 40	19	9.40	3	2.42	16	20.25
41 – 60	110	54.19	56	45.16	54	68.35
> 60	74	36.45	65	52.42	9	11.39
	203	100	124	100	79	100
Mean	55.96		60.33		49.11	

Table 5.7: Distribution of Artisanal Fisherfolks according to their Household Size

Intervals	Entire study		Out-board Fisheries		In-board Fisheries	
	Freq.	%	Freq.	%	Freq.	%
1 up to 3	40	19.70	32	25.81	8	10.13
4 up to 6	61	30.05	47	37.90	14	17.72
7 up to 9	85	41.85	43	34.68	42	53.16
10 up to 12	17	8.37	2	1.61	15	18.99
	203	100	124	100	79	100
Mean	6.21		5.32		7.61	

Table 5.8: Distribution of Artisanal Fisherfolks according to their Level of Formal Education

Variable	Entire study		Out-board Fisheries		In-board Fisheries	
	Freq.	%	Freq.	%	Freq.	%
No Education completed	145	71.43	112	90.32	33	41.77
Primary	49	24.14	10	8.06	39	49.37
Junior and Secondary	9	3.94	2	1.61	7	8.86
	203	100	124	100	79	100
Mean	1.10		0.39		2.27	

Table 5.9: Distribution of Artisanal Fisherfolks according to their Fishing Experience

Interval	Entire study		Out-board Fisheries		In-board Fisheries	
	Freq.	%	Freq.	%	Freq.	%
6 up to 10	16	7.88	15	12.10	1	1.27
11 up to 15	52	25.62	42	33.87	10	12.66
16 up to 20	58	28.57	37	29.84	21	26.58
21 up to 25	49	24.14	18	14.52	31	39.24
26 up to 30	21	10.34	6	4.84	15	18.99
31 up to 35	2	0.99	1	0.81	1	1.27
36 up to 40	0	0.00	0	0.00	0	0.00
41 up to 45	5	2.46	5	4.03	0	0.00
	203	100	124	100	79	100
Mean	19.96		18.42		22.37	

Table 5.10: Distribution of Artisanal Fisherfolks according to their Crew Size

Crew Size	Entire study		Out-board Fisheries			In-board Fisheries	
	Freq.	%	Freq.	%	Crew Size	Freq.	%
3 up to 5	114	56.16	104	83.87	3 up to 5	10	12.66
6 up to 8	59	29.06	18	14.52	8 up to 10	41	51.90
9 up to 10	30	14.78	2	1.61	11 up to 10	28	35.44
	203	100	124	100		79	100
Mean	5.69		4.46			7.62	

Table 5.11: Distribution of Artisanal Fisherfolks according to their Gear Type

Intervals	Entire study		Out-board Fisheries		In-board Fisheries	
	Freq.	%	Freq.	%	Freq.	%
Hook and Line	72	35.47	16	2.42	56	70.89
Gillnet	60	29.56	53	45.16	7	8.86
Mixed	71	34.98	55	52.42	16	20.25
	203	100	124	100	79	100

Table 5.12: Breusch-Pagan / Cook-Weisberg test for Heteroscedasticity

Ho: Constant variance
Variables: fitted values of Yqty_per_day
chi2 (1) = 32.64
Prob > chi2 = 0.0000

Table 5.13: White's General Test for Heteroscedasticity

White's test for Ho: Homoskedasticity		
Against Ha:	Unrestricted Heteroscedasticity	
chi2(101)	=	126.57
Prob > chi2	=	0.0434

Table 5.14: Variance Inflating Factor Test for Multicollinearity

Variable	VIF	Tolerance (1/VIF)
Number of crew	5.69	0.175767
Age of fisherman	4.69	0.213238
Access to ice	3.53	0.283675
Access to extension agent	3.07	0.325486
Type of boat	3.00	0.333212
Primary education	2.79	0.357884
Hook and Line	2.71	0.369458
Household size of fisherman	2.03	0.492775
Mixed gear	1.85	0.539449
Non-fishing income	1.79	0.557682
Junior and Secondary	1.55	0.644301
Access to loan	1.42	0.703896
Fishing experience	1.36	0.735239
Market availability	1.25	0.800127
Cooperatives membership	1.24	0.805586
Access to fuel	1.19	0.837817
Mean VIF	2.45	

Source: Author's own computation from the baseline survey

Table 5.15: R-squared values from the Auxiliary Regressions, Test for Multicollinearity

Dependent variable	R-squared value	Tolerance ($1 - R^2$)
Number of crew	0.8242	0.1758
Age of fisherman	0.7868	0.2132
Access to ice	0.7163	0.2837
Access to extension agent	0.6745	0.3255
Type of boat	0.6668	0.3332
Primary education	0.6421	0.3579
Hook and Line	0.6305	0.3695
Household size of fisherman	0.5072	0.4928
Mixed gear	0.4606	0.5394
Non-fishing income	0.4423	0.5577
Junior and Secondary	0.3557	0.6443
Access to loan	0.1944	0.7039
Fishing experience	0.2648	0.7352
Market availability	0.1999	0.8001
Cooperatives membership	0.1944	0.8056
Access to fuel	0.1622	0.8378

Source: Author's own computation from the baseline survey

Table 5.16: Correlation Matrix of Independent Variables, Test for Multicollinearity

Variables	btt	grt_1	grt_2	grt_3	atth1	atth2	atth3	Expf	age_ hh_ head	hhsize	Lna	Copm	Nfi	Ica	Fua	Mka	crs
Btt	1.0000																
grt_1	0.5909	1.0000															
grt_2	-0.3620	-0.4802	1.0000														
grt_3	-0.2464	-0.5437	-0.4751	1.0000													
atth1	-0.5355	-0.5449	0.3807	0.1824	1.0000												
atth2	0.4706	0.4721	-0.3402	-0.1482	0.5772	1.0000											
atth3	0.1717	0.1905	-0.1395	-0.0576	-0.3447	-0.1215	1.0000										
Expf	0.2886	0.2442	-0.2110	-0.0431	-0.4331	0.3679	0.1414	1.0000									
age_hh_head	-0.5157	-0.4413	0.5080	-0.0434	0.6391	-0.6473	-0.2656	-0.3838	1.0000								
Hhsize	0.4115	0.4022	-0.4654	0.0418	-0.5220	0.4236	0.2660	0.2845	-0.5793	1.0000							
Lna	0.0314	-0.1218	0.2493	-0.1164	0.2445	-0.2597	-0.0072	-0.1858	0.3505	-0.2577	1.0000						
Copm	-0.0884	-0.2134	0.0839	0.1338	0.3431	-0.2273	-0.2564	-0.1780	0.1953	-0.1744	0.1145	1.0000					
Nfi	-0.3168	-0.2494	0.4241	-0.1556	0.3789	-0.3076	-0.1546	-0.2026	0.5770	-0.4095	0.3839	0.1595	1.0000				
Ica	0.4589	0.4291	-0.4536	0.0036	-0.6050	0.5100	0.2390	0.4500	-0.6331	0.6356	-0.3384	-0.2684	-0.5004	1.0000			
Fua	0.0254	0.1291	-0.0434	-0.0880	-0.1484	0.1218	0.0918	0.0806	-0.2147	0.1529	-0.1917	-0.1295	-0.1278	0.3088	1.0000		
Mka	0.2759	0.1184	-0.2066	0.0789	-0.3011	0.2700	0.0812	0.1892	-0.3087	0.2774	-0.0841	-0.1080	-0.2800	0.3523	0.1396	1.0000	
Crs	0.7498	0.6079	-0.5063	-0.1255	-0.7024	0.6061	0.2654	0.4076	-0.7429	0.6103	-0.2544	-0.2145	-0.4887	0.7000	0.1291	0.2863	1.0000
Tgaex	0.4589	0.3670	-0.4536	0.0659	-0.6491	0.5795	0.1908	0.4367	-0.7153	0.6063	-0.2918	-0.1879	-0.5214	0.7411	0.1489	0.3745	0.6566

Source: Author's own computation from the baseline survey

Table 5.17: Fishing Operational Costs (per kg of fish in Nakfa)

Production cost item	Houris –petrol boats	Sambucks diesel boats
Fuel	2.75	0.41
Oil	0.50	0.02
Ice	0.32	0.32
Labor- food	1.13	0.56
Salary	0.46	2.20
Royalty	0.15	0.15
Berth & port fees	0.01	0.01
Maintenance	0.58	0.29
Depreciation	0.86	0.77
Other costs 5%	0.34	0.25
Total cost	*7.1*	*4.98*

Source: ERIDAL Fisheries[20] (n.d.)

[20] ERIDAL Fisheries (n.d.): Eritrean and Dalian Chinese Fishing, Processing and Exporting Company.

Appendix D

Questionnaire for Key Informant

The main objective of this questionnaire is to assess the peculiarities of the artisanal fishing business. Since the reliability and credibility of the research outcome depends up on the information you render in this questionnaire, I suggest for your kind cooperation.

1. In your opinion what do you think for the current poor performance of the artisanal fishing business in Eritrea?

   ____
   ____
   ____
   ____
   ____

2. What are the factors that are crucial to the exploitation of the fishery resources in view of the artisanal fish harvest?

   ____
   ____
   ____
   ____
   ____

3. Are there any opportunities for improving artisanal fishers' fish catch level?

   ____
   ____
   ____
   ____
   ____

4. What are the constraints for pursuing these opportunities/ideas? (such as, lack of skills, lack of resources, fishing technology, distance to markets, etc.)

   ____
   ____
   ____
   ____
   ____

5. Do the artisanal fishers have access to credit facilities for the acquisition of fishing inputs in terms of keeping the operation running and/or buying fishing vessels? If yes, how is the utilization and repayment of this loan?

   ____
   ____

6. What are the reasons or obstacles why the fishers have not organized? Do you think being part of the cooperative improve the performance of artisanal fishing? If yes how? If no why?

7. How is the marketing of artisanal fish harvest performing?

8. What are some of the major problems with respect to marketing artisanal fish catch?

9. In your opinion what infrastructural facilities are needed that would contribute to enhancement of artisanal fishers' fish catch level?

10. How did you consider the inception of mobile phone in the coastal artisanal fishing community in the performance of the fishing business?

11. Comments:

Thank you for your cooperation

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