



**Department of Economics**  
**Mahatma Gandhi School of Economics and Commerce**  
**ASSAM UNIVERSITY, SILCHAR**  
**(A Central University Constituted under Act XIII, 1989)**  
**Silchar- 788011, Assam, India**

---

## **DECLARATION**

I, Sri Manish Roy, bearing Registration No. Ph.D./1644/2011, dated 21/09/2011, hereby declare that the subject matter of the thesis entitled “Technical Efficiency of Fish Catch and Its Socioeconomic Determinants. A Study on traditional fishing population of Karimganj district”, is the record of work done by me and that the contents of this thesis did not form the basis for award of any degree to me or to anybody else to the best of my knowledge. The thesis has not been submitted in any other University/Institute.

Place: Silchar

Date:

(Manish Roy)

## ACKNOWLEDGEMENTS

I would like to express my deep gratitude and deepest regards to my esteemed supervisor, Dr. Ritwik Mazumder, Assistant Professor in Economics, Assam University, Silchar, for his generous cooperation, amicable behavior, valuable time, suggestions, constant encouragement and showing hope at every moment during the course of present work. It was all due to his kindness and support that the present work could be taken up and completed successfully. I will remain ever indebted to him.

I wish to express my sincere gratitude to Prof. Niranjan Roy, HOD, Department of Economics and Dean, Mahatma Gandhi School of Economics and Commerce, Prof. Sumanash Dutta, Department of Economics, Prof. M. A. Ansari, Department of Economics, Prof. Alok Sen, Department of Economics, Assam University, Dr. Avijit Debnath, Assistant Prof., Department of Economics, and all other teachers of the Department of Economics, Assam University, Silchar, for their valuable advice and suggestions till the accomplishment of the goal.

In addition I am grateful to Dr. Mahuya Sen Gupta, Assistant Prof., Department of Biotechnology, Assam University, for her encouragement in my research work. I also greatly thank the Principal of S.K. Roy College, Katlicherra, Governing body along with all other staff and students of my college because of their encouragement during the course of my research work.

My express my sincere thanks to secretary of Sone Beel Co-operative Society, Mr. Tapon Das and local members of Sone Beel region for their support and assistance in this aspect. I am also grateful to my most beloved sir Mr. Anjan Saha (Sanku Sir) who taught me how to hold the pen for Economics and also stimulated in the field of

academic journey. I would like to thank my well wishers, my friends, namely Arpita Das, Monalisa Das and many others because of their encouragement and help in various stages of my work. They have directly and indirectly helped me in my research endeavor. I also grateful to my family member especially my loving mother Minoti Roy, my father Manoj Ranjan Roy, my sisters and my brother of their relentless encouragement and support in my research work.

The present work is the fruit of inspirational support of a large number of individuals, specially, respondents and institutions. I am equally grateful to all the editors, publishers and copyright holders of different sources cited here from where I have drawn materials.

Last but not least I convey my gratitude to all the well wishers of my locality in Hailakandi and Katlicherra those who have actively supported me. I am thankful to God Almighty for all the blessings showered on me.

**Manish Roy**

## PREFACE

For a long time fishing has been regarded as one of the most important livelihoods in eastern and north eastern India and Assam is no exception. Small scale fishing forms the basis of livelihood of numerous households living in the neighborhood of the Son Beel in Karimganj district of southern Assam or what is otherwise called the Barak Valley region. Son Beel is the largest wet land and catchment area of the region which floods during the monsoons and shrinks during winters and springs. The fisheries sector is almost entirely dominated by small scale, poor fishing households who produce a major portion of total freshwater fish catch in the district. However, the region has witnessed a poor performance in fishing especially in terms of productivity or catch per unit effort. Various factors are responsible behind the backward informal nature of fishing in the Sone Beel. The peak fishing season (monsoon months) is characterized by open access where there is crowding of efforts due to unrestricted fishing whereas restrictions are imposed only during slack seasons (winter months) when the water body shrinks and is confined to a limited area. Moreover lack of technical skills and capital prevents the fishing households to go beyond the traditional methods. With the scarce resources and growing fish demand, decision makers (policy makers and households) face the challenge of developing a sustainable small-scale fisheries sector, which can integrate socio-economic and environmental objectives in their planning decisions.

As already mentioned, fishermen in the area have been plagued by a number of problems. These include poor and inefficient fishing gears and vessels, lack of capital, poor fisheries management, limited access to better market coupled with poor

handling facilities, poor infrastructure and high post-harvest losses. Together with a lack of alternative employment opportunities and rapidly increasing number of fishing households, the above mentioned problems have been the main cause of the decrease in fish catch as well as degradation of fish stock on account over-exploitation. As a result, most households will continue to be trapped in poverty. The main challenge for the growth of small-scale fisheries is how to improve production and performance while, at the same time, ensuring sustainable level of fisheries resources. Therefore, measurement and analysis of performance and efficiency of small-scale fishing teams are important.

Various initiatives need to be undertaken by governmental and non-governmental organizations in order to ensure that fishing activities bring about economic and social benefits in the Sone Beel area. Specifically there are reasons to believe that an enormous amount of improvement can be made in the directions of income, health and education. In the context of the Sone Beel it is extremely important to make small-scale fishing households more efficient, while finding a way to conserve fisheries resources by combining limited access to fisheries resources with sufficient incentives for existing catchers to exit the sector. However, these initiatives must consider the importance of small-scale fishing household's behaviour in their decision-making process. Although the importance of fishing households' behaviour has often been raised in policy debates on inland water fishery resources management, little empirical evidence is available on the validity of such arguments. This implies that there is a need to understand the nature of small-scale fishing households' operations and how small-scale fishing households respond to regulations or other stimuli with respect to their preferences. This will enable policy makers to develop

efficient policies targeting both aquatic resources conservation and welfare of fishing households’.

In a nutshell catch efficiency is important but so is the issue of sustainability and resource conservation. Unfortunately the issue of conservation is not the primary task of this thesis, which is entirely dedicated to technical efficiency measurement and its non-input determinants. Poor fishermen would always be tempted to go for over fishing, which would result in loss of stock and aquatic species and would ultimately result in collective poverty and misery for the entire fishing community. Catch per unit effort would decline with falling stock, and so would average productivity and efficiency. Earnings would fall raising absolute poverty. This has been the experience with small scale fishermen in the Sone Beel in recent years.

The present study is arranged and demonstrated in five different chapters. General introduction of the study is elucidated in Chapter-1. In this chapter, numerous important issues associated with marine and inland water fishery in the Indian context are first discussed. Relevant statistics relating to the fishery sector in Assam are also briefly discussed. The discussions take into account the present scenario and the quantity of fish production in Assam. Issues related to statement of the problem, the necessity scope and importance of the study is discussed. Geographical features of the study region and method of fish catch operation are discussed. Fishing techniques and methods, including fishing tools, gears, vessels etc are appropriately described. Discussions also cover restrictions on catch across fishing seasons, catch and sale of under-sized fish (under grown), restrictions on the use of nets in inland fishery and associated issues. The socio-economic features of the fishing community are also outlined. The objectives and hypothesis of the present study are explained. The

purpose of this section is to present a comprehensive view of the basic ground and necessities of the sustainable fishing and fish stock are being emphasized.

Chapter-2 of the thesis presents review of literature under two broad categories. The first relates to historical development of the conceptual framework of economic efficiency and the technicalities of econometric measurement. The second kind of reviews is on the most significant empirical contributions in the field of measurement of technical efficiency in the field of fishing areas. Finally a discussion on the research gap of the previous studies is outlined.

The purpose of the Chapter-3 is to present the analytical foundations of measurement of efficiency, formulation of the stochastic production frontier and sampling design and collection of primary data are expressed in detail. The next two sections are devoted respectively to the basic stochastic production frontier model of Aigner *et al.*, (1977) and the specific econometric strategy adopted in the present study. All variables selected and constructed are first defined. Next, the rationale behind each variable construction, i.e., the measurement methods for each variable selected for stochastic frontier analysis is elaborated in this section.

Chapter-4 chapter presents the empirical results along with economic explanation or validation of the results. The summary statistics and bi-variate correlation analysis are routinely presented before each frontier regression results. The complete parameter estimates of each frontier model for both team as well as individual catchers are presented with significance levels. The distributions of technical efficiency score of single and paired boats teams with multiple catchers as well as distribution technical efficiency of single boat single catchers are shown in the form of frequency distribution tables. The living conditions and quality of life of the catchers are also analysed in depth. Housing, sanitation, education, non-fishing

income among a few others, are a few the aspects dealt with to understand quality of life among fishermen and their households. Lastly, economic viability of fish catch as an occupation over generations is discussed. Chapter-5 relates to summary and policy conclusion of the present work, which are drawn on the basis of the principal findings of the study.

It is hoped that the thesis will be of considerable help to socio-economic planners and policy makers of the region. This thesis is the first of its kind on the measurement of efficiency of fishing in the Sone Beel. Thus all researchers and scholars working on similar problems both in this region as well as in the rest of the country would find this thesis helpful. No study can be considered as sufficient and this is applicable for this research as well. It is thus hoped that readers would find the study useful and would contribute positively towards its improvement through further studies either in this region or in the rest of India.



## List of Acronym

AE	=	Allocative efficiency
AFA	=	American Fisheries Act
APL	=	Above Poverty Line
B	=	Boat
BPL	=	Below Poverty Line
CRS	=	Constant Returns to Scale
DDF	=	Directional Distance Function
DEA	=	Data Envelopment Analysis
DMUs	=	Decision Making Units
DR	=	Dori
DRS	=	Decreasing Returns to Scale
EDU	=	Education
EE	=	Economic efficiency
EXP	=	Experience
GAMS	=	General Algebraic Modeling System
HTD	=	Housing type dummy
IAY	=	Indira Awaas Yojana
IUCN	=	International Union for Conservation of Nature
JMP	=	Joint Monitoring Programme
KT	=	Kathi
L	=	Labour
MGNREGS	=	Mahatma Gandhi National Rural Employment Guarantee Scheme

MLE	=	Maximum Likelihood Estimates
MPT	=	Manual Propulsion Technology
MT	=	Metric tons
N	=	Net
NFI	=	Non-Fishing Income
NSSO	=	National Sample Survey Organisation
OET	=	Outboard Engine technology
OLS	=	Ordinary least square
RCC	=	Reinforced Cement Concrete
SAND	=	Sanitation System Dummy
SE	=	Scale Efficiency
SFCSL	=	Sone Beel Fishermen Co-operative Society Limited
SPF	=	Stochastic Production Function
TE	=	Technical Efficiency
TFC	=	Total Fixed Cost
TFP	=	Total factor productivity
TVC	=	Total Variable Cost
UNICEF	=	United Nations Children's Emergency Fund
VRS	=	Variable Return to Scale
WHO	=	World Health Organization

# CONTENTS

	Page No
<b>Declaration</b>	ii
<b>Certificate</b>	iii
<b>Acknowledgement</b>	iv
<b>Preface</b>	vi
<b>List of Acronym</b>	xi
<b>List of Tables</b>	xvi
<b>List of Figures</b>	xix
<b>List of Maps</b>	xx
<b>CHAPTER-1 INTRODUCTION</b>	<b>1-47</b>
1.1 Present Scenario of fishery in India vis-a-vis Assam	
1.2 Statement of the Problem	
1.3 Necessity Scope and Importance of the Study	
1.4 A Brief Profile of the State of Assam	
1.5 Demographic outline of the Karimganj district	
1.6 Profile of the Study Area	
1.6.1 Geographical location of Sone Beel region	
1.6.2 Social History of People of Sone Beel	
1.6.3 Ecology of Sone Beel	
1.6.4 Fishery Co-operative Society	
1.6.5 Classification of wetlands in Assam	
1.6.6 Fishermen in Sone Beel	

1.6.7	Fishing gears and Fish Catch Methods in Sone Beel	
1.6.8	Standard Techniques of Fish Catch in Sone Beel during Peak Season	
1.6.9	Government Restrictions on fish catch related issues in Assam	
1.6.10	Marketing of Fish in Sone Beel	
1.7	Theoretical and Conceptual Framework	
1.8	Objectives and Hypotheses	
<b>CHAPTER -2 REVIEW OF LITERATURE</b>		<b>48-93</b>
2.1	Theoretical Development of the Stochastic Production Frontier	
2.2	Literature on Efficiency Measurement in Fisheries	
2.3	The Research Gap	
<b>CHAPTER -3 MODELS METHODOLOGY AND DATA</b>		<b>94-129</b>
3.1	Analytical Foundations of Measurement of Economic Efficiency	
3.2	Formulation of the Stochastic Production Frontier	
3.3	The Basic Cross-Sectional Model and Method of Estimation	
3.4	The Normal-Truncated Normal Model	
3.5	The Econometric Approach for the Present Study	
3.6	Variable Construction and Measurement	
3.7	Survey Methods and Data	
<b>CHAPTER -4 EMPIRICAL RESULTS AND ANALYSIS</b>		<b>130-183</b>
4.1	Analysis for Net Using Fishing teams with Single and Paired Boats (Sample size = 165)	

4.2	Regression Results of Team Catchers – Estimation of Team Level Technical Efficiency with and without Inefficiency Effects	
4.3	Socio-Economic Characteristics of Individual Catchers or Single Catchers	
4.4	Production Frontier Analysis of Single Catchers Using Boat and Net	
4.5	Analysis of Single Catchers using Traditional Fishing Tools and Equipments	
4.6	Economic Viability of Fishing as a Sustainable Occupation	
 <b>CHAPTER -5 SUMMARY AND POLICY CONCLUSIONS</b>		<b>184-194</b>
5.1	Summary of the study	
5.2	Policy Recommendations	
5.3	Possible Extensions of the Study	
 <b>BIBLIOGRAPHY</b>		<b>195-205</b>
 <b>APPENDICES</b>		<b>206-212</b>
A.	The Interview Schedule	
B.	Presentation of Research Paper in Seminars and Conferences/ Participation in Workshops	
C.	Publications	

## LIST OF TABLES

Table No.	Title of the Table	Page Number
1.1.1	India's share in World fish production for the year 2009 (metric tons)	5
1.1.2	Fish production, growth rate and fish seed production in India (2004-05 to 2014-15)	6
1.1.3	Fish production trends, growth rate and seed production in Assam during 2004-05 to 2015-16.	7
1.1.4	Some statistics of Fishery in Assam, 2014-15	8
4.1.1	Boat Sightings and Arrival in the Sone Beel during Survey Week	133
4.1.2	Number of Boats Sighting in the Sone Beel during the Survey Week	135
4.1.3	Types of Fish Commonly Caught by Catchers in the Sone Beel	136
4.1.4	Summary Statistics of Variables for Multiple member Team Catchers (N =165)	137
4.1.5	Pair-wise Correlation Matrix1 (N= 165)	138
4.1.6	Frequency Distribution of Value of Catch (Rs/month) of team catchers (N=165)	139
4.1.7	Frequency Distribution of Boat size in meters of the team catchers. (N=165)	140
4.1.8	Frequency Distribution of Net size in meters of the team catchers (N=165)	140
4.1.9	Frequency Distribution of Labour hours of the team catchers (N=165)	140
4.1.10	Frequency Distribution of Average Age across fishing teams (N=165)	141
4.1.11	Frequency distribution of average years of formal Schooling of fishing teams (N=165)	141

4.1.12	Frequency Distribution of Average monthly Non-fishing Income (in Rs/month) of Fishing teams (N=165)	142
4.2.1	OLS Estimates of Cobb-Douglas Production Function (N=165)	144
4.2.2	White's Heteroscedasticity Test	144
4.2.3	Cobb-Douglas Stochastic Production Frontier Estimates under Normal – Half-normal Error Structure (N=165)	145
4.2.4	Cobb-Douglas Stochastic Production Frontier : Normal half-Normal and Normal - Truncated Normal Error Models Compared	146
4.2.5	Cobb-Douglas Stochastic Production Frontier with Inefficiency Effects	147
4.2.6	Likelihood Ratio Tests of Restrictions on Production Frontier Parameters (N = 165)	149
4.2.7	Distribution of Technical Efficiency of all Teams (N = 165)	152
4.3.1	Livelihood pattern of the sample fishing households (N=160)	154
4.3.2	Number of fishing households received Housing Scheme (Indira Awaas Yojana)	158
4.3.3	Access to Micro-credit	160
4.3.4	Age distribution of Single Catchers	160
4.3.5	Educational attainments of Single Catchers in Sone Beel	161
4.3.6	Distribution of Experience of Single Catcher fishermen in the Sone Beel	162
4.3.7	Frequency Distribution of Value of Catch of Single catchers (Rupees/month)	163
4.4.1	Summary Statistics of variables for single catchers team (N=100)	164
4.4.2	Cobb-Douglas Stochastic Production Frontier Estimates under Normal – Half-normal Error Structure (N = 100)	166
4.4.3	Cobb-Douglas Stochastic Production Frontier : Normal half Normal and Normal - Truncated Normal Error Models Compared for Single Catchers (N = 100)	167
4.4.4	Cobb-Douglas Stochastic Production Frontier with Inefficiency Effects (N = 100)	169

4.4.5	Likelihood Ratio Tests of Restrictions on Production Frontier Parameters (N = 100)	170
4.4.6	Distribution of Technical Efficiency of single catcher teams (N = 100)	173
4.5.1	Summary Statistics of variables for single catchers without Net (N=60)	174
4.5.2	Cobb-Douglas Stochastic Production Balatkar Estimates under Normal – Half-normal Error Structure (ALS, 1977)	175
4.5.3	OLS Estimates of Cobb-Douglas Production Function for non net users (N=60)	177
4.5.4	Breusch-Pagan-Godfrey Heteroskedasticity Test	177
4.6.1	Single catcher households living Above and Below Poverty Line	180



## LIST OF FIGURES

Figure No.	Title of the Figures	Page Number
1.6.7	Traditional fishing gears used by the fishermen in Sone Beel	36
3.2.1	Input output correspondence	95
3.2.2	Input output correspondence	95
3.2.3	Input output substitution	97
3.2.4	Production function	97
3.2.5(a)	Production frontier	98
3.2.5(b)	Production frontier	98
3.2.6(a)	Output distance function	99
3.2.6(b)	Output distance function	99
3.2.7(a)	Technically optimal scale	100
3.2.7(b)	Frontier production function	100
3.2.8	Cost efficiency	101
4.1.1	Boat Sightings and Arrival in the Sone Beel during Survey Week	135
4.1.2	Number of Boats Sighting in the Sone Beel during the Survey Week	136
4.2.1	Frequency Distribution of Technical Efficiency of all Teams (N = 165)	152
4.2.1a	Log of Actual output and log of frontier output for Team catchers (N=165)	153
4.3.1	Source of Drinking water	158
4.3.2	Number of families having Sanitation facility	158
4.3.3	Distribution of Beneficiaries and Non-beneficiaries under Indira Awaas Yojana	159
4.3.4	Educational attainments of Single Catcher Fishermen in Sone Beel (N=160)	161
4.3.5	Experience of fishing of single catcher team (N=160)	163
4.3.6	Monthly value of fish caught by Single catchers (N=160)	164
4.4.6	Frequency Distribution of Technical Efficiency of single catcher team (N = 100)	174

## LIST OF MAPS

<b>Maps No.</b>	<b>Title of the Maps</b>	<b>Page Number</b>
1.4.1	District map of Assam	13
1.4.2	District map of Karimganj	15
1.4.3	Boundary contour Map of Sone Beel at different storage levels	17