Journal of Aquatic Biology and Fisheries Vol. 2/No. 2/2014/pp. 69 to 74

ECONOMIC SUSTAINABILITY OF MARINE FISHERIES IN INDIA: A TOTAL FACTOR PRODUCTIVITY APPROACH

Aswathy, N[1]*., Narayanakumar, R[1]. and Somy Kuriakose[2]
[1] *SEETTD, Central Marine Fisheries Research Institute, Kochi, India*
[2] *Senior Scientist,, FRAD, Central Marine Fisheries Research Institute, Kochi, India*
**Email: aswathy.icar@gmail.com*

Received on: 10 October 2013, accepted on: 12 December 2013

Abstract: Marine fisheries sector of India has transformed from the status of subsistence fishery to that of multibillion dollar industry with the technological advancements in harvesting and post-harvest operations. Intensive shrimp trawling with multi-day fishing trips, introduction of purse seines in the late eighties and enhancement of overall fishing effort have resulted in declining catch per unit effort of different fishing units. The declining catch rates of high value fishes will have a serious impact on the economic sustainability of marine fisheries sector and livelihood security of fisher folk. The objective of the study was to assess the performance and economic sustainability of marine fish production in India by using total factor productivity growth for the period 2000 to 2010. Total factor productivity is a measure of the productivity of all inputs, or factors of production, in terms of their combined effect on output and is often accounted for by technological change or more efficient methods of producing output. TFP serves as an indicator of the performance of any production system and sustainability of the growth process. Gear wise and species wise catch -effort data and species wise average marine fish prices in different states of India obtained from Central Marine Fisheries Research Institute for the period 2000-10 were used for the analysis. The total factor productivity growth in marine fisheries sector in India was estimated using Divisia-Tornqvist indexing method. Results of the study indicated that 76 percent of the fuel requirement in the fishing industry was in the trawl sector followed by dolnetters (12 per cent), gillnetters (9 per cent) and others (3 per cent). The total diesel consumption in the year 2010 was 1,218 million litres. The average quantum of labour stood at 105 million days during 2000-10 period and nearly 70 percent of which was contributed by the mechanized sector. The input index showed a positive growth of 1.7 percent during 2000 to 2010. The output indices calculated from the quantities and revenue shares of the different resources during 2000 to 2010 period showed a growth rate of 3.4 percent. The total factor productivity showed a positive growth of 1.65 percent during 2000-10 at all India level. The state wise analysis indicated that the total factor productivity growth was positive in the east coast with a growth rate of 8.16 percent whereas in the west coast the total factor productivity growth was negative in the states of Kerala (-3.69%) and Maharashtra (-5.83%). The positive growth in total factor productivity in the east coast indicated economic sustainability of the fishing industry in the short run. Even though there was substantial increase in marine fish prices in the past decade, reduction in catches of high value fishes like crustaceans, high cost of fuel and labour led to reduced economic efficiency of fishing operations in Kerala and Maharashtra. Since marine fisheries in the country is a state subject, appropriate remedial measures are necessary for each maritime state to reduce the fishing pressure.

Key words: Divisia-Tornqvist index, Factor productivity, Factor shares, Revenue shares, Input index, Output index

INTRODUCTION

India ranks second in culture and third in capture fisheries production among the Asian countries and occupies seventh position among the fish producing nations of the world. Marine fishery resources of India comprise an Exclusive Economic Zone (EEZ) of 2.02 million sq. km. and with 0.512 million sq.km of continental shelf area. During the 1950[s], India's marine fishery was merely at subsistence level and was mainly exploited by artisanal fishermen. Commercial fishing activities were initiated by introducing trawling in the 60[s] and later purse seining techniques. Mechanization and motorization resulted in increasing the fishing capacity by extending the areas of operation beyond the 50 m depth zone and up to 150 m depth. The marine fishery in India is multi species and multi fleet and characterized by regulated open access.

The fishing fleet consists of less than 20 meter OAL vessels which includes mechanized trawlers, mechanized gillnetters/hooks and lines, mechanized dolnetters, mechanized ring seiners, purse seiners, motorized and non-mechanized units. There are 10 maritime states in the country covering the east and west coasts. The Maximum Sustainable Yield (MSY) of the fish stocks from the Indian EEZ has been assessed as 3.9 million tonnes which included the demersals(1.93 million tonnes), pelagics (1.74 million tonnes) and oceanic (0.25 million tonnes) resources (Sudarsan *et al*., 1990).

Marine fisheries sector of India has transformed from the status of subsistence fishery to that of multibillion dollar industry with the technological advancements in harvesting and post-harvest operations. Intensive shrimp trawling with multi-day fishing trips, introduction of purse seines in the late eighties and enhancement of overall fishing effort have resulted in declining catch rates. The marine fish production increased in states like West Bengal, Orissa, Andhra Pradesh and Tamil Nadu in the east coast whereas the marine fish production declined in the west coast states like Maharashtra, Goa and Gujarat during 2000 to 2010 period (Sathiadhas *et al.*, 2012). The declining catch rates of high value fishes will have a serious impact on the economic sustainability of marine fisheries sector and livelihood security of fisher folk. Hence an attempt is made in this paper to assess the performance and economic sustainability of marine fish production in India by using Total Factor Productivity (TFP) approach for the period 2000 to 2010. The major objectives of the study were:

1) To calculate the revenue and cost components in overall marine fish production in India based on the annual catch and fishing effort details
2) To develop the input, output and total factor productivity indices and to estimate the total factor productivity growth in the marine fisheries sector in India for the period 2000 to 2010.
3) To comment on the economic sustainability of marine fisheries in India and to suggest appropriate policy measures

Several international studies analyzed the total factor productivity in marine fisheries sector. Arnason(2000) measured the productivity growth in the Icelandic fisheries during the period 1975 to 1995. The standard theory of total factor productivity (TFP) was extended to accommodate the special case of fisheries, by including the size of the fish stocks as one of the input variable. The results indicated that the average annual growth in total factor productivity has been higher than that of other major industries in Iceland and abroad.

Hannesson (2005) studied the development of productivity in the Norwegian fisheries during the period 1961-2002 using data on catches at constant fish prices, capital stock, labour input and fish stocks. The total factor productivity has increased rapidly in the mid 60^{s} which was proved to be due to technological progress. The total factor productivity analysis of Indian Agriculture by Amarender Reddy (2009) indicated that TFP growth of all crops, except paddy, groundnut and jute has declined with negative growth. The results also showed that there was a significant monetary benefit to farmers through crop diversification to pulses and oilseeds, in addition to food security.

MATERIALS AND METHODS

The total factor productivity growth in marine fisheries sector in India was estimated using Divisia-Tornqvist indexing method. In the production function framework, TFP growth indicates technical progress, which represents shifts in the production function over time. Total factor productivity is a measure of the productivity of all inputs, or factors of production, in terms of their combined effect on output and is often accounted for by technological change or more efficient methods of producing output. TFP serves as an indicator of the performance of any production system and sustainability of the growth process. Gear wise and species wise catch -effort data and species wise average marine fish prices in different states of India obtained from Central Marine Fisheries Research Institute (Government of India) for the period 2000-10 were used for the analysis.

TFP index was worked out as follows;

TFP index - Output index / Input index

Input index= $\Pi_i(X_{it}/X_{it-1})^{(S_{it}+S_{it-1})1/2}$

Where Xit and Xit-1 are the quantities of input i at time t and t-1

Sit and Sit-1 are the shares of input i in total cost at time t and t-1

Similarly output index was workout as follows:

Output index $=\Pi_j(Q_{jt}/Q_{jt-1})^{(R_{jt}+R_{jt-1})1/2}$

Where Q_{jt} and Q_{jt-1} are the quantities of resource j at time t and t-1

R_{jt} and R_{jt-1} are the shares of resource j in total revenue at time t and t-1

t is the number of years (Kumar and Jha,2005).

Fuel, labour and fixed capital were used as the input variables for working out the input index. Fuel used in the marine fisheries sector of India consists of diesel and kerosene. The fuel used in the fishing industry was estimated based on average fuel consumption per hour of operation for all the fishing units. The data was validated by using total diesel sales data from the different diesel pumps, data from fishermen societies and information on diesel subsidy given by various state departments of fisheries. The data on kerosene was estimated based on the number of motorized units operated per year and average kerosene consumption per fishing trip. Labour employed in the marine fishing industry (Mechanized/motorized/Non-mechanized sectors) was estimated in terms of labour days. The fixed capital was estimated from the number of boats and investment details on each category of fishing unit.

RESULTS AND DISCUSSION

The total factor productivity indices were developed based on the input and output indices calculated for the period 2000 to 2010. Fuel, labour and fixed capital used in the fishery were used for developing the input index.

Fuel consumption in the marine fishing sector

The average fuel consumption in the fishing industry varied from 1000 million litres and on an average every tonne of fuel produced 3.5 tonnes of fish. The FAO-World bank report (2010) showed that at global level the catch per tonne of fuel in the small scale fisheries was at 1-3 tonnes and at large scale fisheries at 1-4 tonnes. Mechanized trawlers are the prominent fishing units in the country and 76 percent of the fuel requirement in the fishing industry goes to the trawl sector followed by dolnetters(12 per cent), gillnetters (9 per cent) and others(3 per cent). State wise diesel

Table 1. Total labour days in the marine fishing sector in India

Years	Mechanized	Motorized	Non- Mechanized	Total
2000	57307371	25619374	11952713	94879458
2001	57690087	25696925	11185388	94572400
2002	67336620	27326618	10434496	105097734
2003	69955470	28144464	12357145	110457079
2004	66359803	26672351	11649156	104681310
2005	68682056	22361623	9031159	100074838
2006	75602658	25135175	8578955	109316789
2007	74375956	26891229	7843241	109110426
2008	78990430	27042898	6176943	112210271
2009	81479299	25081136	6069580	112630015
2010	71711318	22950077	4593510	99254905
Average	69953733	25720170	9079299	104753202

consumption showed that the maximum diesel consumption is in the state of Gujarat where the maximum number of mechanized boats operates. The total diesel consumption in the year 2010 was 1,218 million litres.

Employment and labour days in marine fishing

Labour used in marine fishing industry was estimated in terms of number of days employed per worker per annum. The labour consists of three categories- mechanized, motorized and non-motorized. The mechanized category included vessels of less than 20 m OAL, which used mechanization both for propulsion as well as for fishing operations. The motorized category consisted of outboard motor fitted boats and non- mechanized category consisted of the traditional wooden canoes without any engine. The labour cost included both wages and crew shares received by the fishermen. The average quantum of labour stood at 105 million days during 2000-10 and nearly 70 per cent of which is contributed by the mechanized sector (Table 1). The labour cost in the marine fishing sector was Rs.62 billion and the diesel cost was Rs. 36 billion in 2010 at current prices.

Growth in fishing fleet and investment

The number of mechanized units increased from 47,000 units in 1998 to 72,229 units in 2010. There was drastic rise in the number of mechanized units during 1980 to 1998 period recording 148 per cent growth. The growth was 23 per cent only during 2005 -2010 period but the days of fishing and actual fishing hours increased. The motorized units also increased from 32,000 units in 1998 to 71,256 units in 2010. The number of non-mechanized units drastically reduced from 1,60,000 units in 1998 to 50,591 in 2010 (Table 2).

Fleet wise contribution to gross earnings realized at first sales showed that in the west coast, nearly 82 per cent of the gross earnings was realized from mechanized sector, 16.5 per cent from motorized sector and 1.5 per cent from the non-mechanized sector. In the east coast, mechanized sector contributed 60 percent, followed by motorized (24 per cent) and non-mechanized sectors (16 percent). Investment in fishing units increased from Rs.40 billion in 1998 to Rs. 151 billion in 2010. The gross earnings realized from the mechanized sector was Rs.188 billion and the investment was Rs.136 billion (Table 3). The input index showed a positive growth of 1.7 percent during 2000 to 2010.

Table 3. Category wise gross earnings and investment (2010) (Rs. billion)

Category	Gross earnings	Investment
Mechanized	188.22	136.29
Motorized	35.17	13.7
Non- motorized	3.07	1.63
Total	226.47	151.63

Landings, revenue shares and output index

The marine fish production increased from 2.65 million tonnes to 3.32 million tonnes during 2000 to 2010. Species wise analysis showed that the quantity of clupeids increased from 6.37 lakh tonnes in 2000 to 9.29 lakh tonnes in 2010. The quantity of other low value pelagics consisting of Bombay duck, half and full beaks, flying fishes, ribbon fishes, bill fishes and barracudas stood at around 3 lakh tonnes. The quantity of mackerels almost doubled from 1.34 lakh tonnes to 2.67 lakh tonnes. The resource wise average share in the gross revenue earned at landing

Table. 2. Growth of fishing fleet in the country

Years	Non-mechanized		Motorized		Mechanized		Total	
	Number	Growth Rate (%)	Number	Growth Rate (%)	Number	Growth Rate (%)	Number	Growth Rate (%)
1980	137000		---	---	19013		156013	
1998	160000	17	32000	---	47000	147	239000	53
2005	104270	-35	75591	136	58911	25	238772	-0.1
2010	50591	-51	71256	-6	72229	23	194146	-19

centres during 2000-10 showed that the maximum share was contributed by crustaceans (40 percent) followed by clupeids (11 percent), low value demersals (9 percent), cephalopods (8 per cent), seer fishes (6 percent) and pomfrets (5 percent). The output indices calculated from the quantities and revenue shares of the different resources during 2000 to 2010 period showed a growth rate of 3.4 percent (Table 4).

Table 4. Input, output and Total factor productivity indices in India (2000-2010)

Years	Output index	Input index	TFP index
2001	100.00	100.00	100.00
2002	111.26	111.90	99.43
2003	111.84	114.93	97.31
2004	104.36	110.84	94.16
2005	97.06	105.02	92.42
2006	115.45	115.85	99.66
2007	117.36	116.69	100.57
2008	135.68	119.31	113.72
2009	134.42	121.21	110.90
2010	135.01	122.32	110.37
CGR	**3.40**	**1.72**	**1.65**

The total factor productivity showed a positive growth of 1.65 percent during 2000-10 at all India level. The state wise analysis indicated that the total factor productivity growth was positive in the east coast with a growth rate of 8.16 percent whereas in the west coast the total factor productivity growth was negative in the states of Kerala (-3.69%) and Maharashtra (-5.83%) (Table 5). The positive growth in total factor productivity in the east coast indicated economic sustainability of the fishing industry in the short run. Several factors including improvement in fishing technology, favourable resource stock of certain species, fishery management measures, public and private investments in capture fisheries sector might have contributed to the positive TFP growth in the sector.

The marine fish production in the major fish producing states of Maharashtra and Kerala showed declining catch trends of high value resources like shrimps and increase in the catches of low value fishes like oilsardines and mackerels. Deshmukh (2006) reported that among 20 commercially important resources, Bombayduck, silver pomfret, elasmobranches and lobster resources have declined significantly in Maharashtra. In Kerala state, even though the conversion to high speed engines by the mechanized units contributed to increase in catches, the catch was dominated by low value resources. Even though there was substantial increase in marine fish prices in the past decade, reduction in catches of high value fishes like crustaceans, high cost of fuel and labour led to reduced economic efficiency of fishing operations in Maharashtra and Kerala.

Table 5. Total factor productivity growth of marine fisheries in different coastal states in India (2000-2010)

States	TFP growth (%)
West Bengal	6.42
Orissa	18.06
Andhra Pradesh	5.80
Tamil Nadu	4.18
Puducherry	13.75
East coast	**8.16**
Kerala	-3.69
Karnataka	2.88
Goa	4.52
Maharshtra	-5.83
Gujarat	3.15
West coast	**-0.17**
All India	**1.65**

The positive total factor productivity of marine fisheries at all India level indicated the production system in India is economically sustainable. However the negative total factor productivity in the major producing states of Kerala and Maharashtra needs special attention. Since marine fisheries in the country is a state subject, appropriate remedial measures are necessary for these maritime states to reduce the fishing pressure. The reduction in profit levels of fishing units may lead to reduced fishing effort in the long run with the characteristic boom and buzz game of open access common property marine fishery resources. However efforts are necessary to manage the fishery based on some community based measures to improve

the profitability of fishing operations and development and promotion of fuel efficient and profitable fishing methods.

ACKNOWLEDGEMENTS

The authors are thankful to the Director, CMFRI for the facilities provided for undertaking the research work.

REFERENCES

Amarender Reddy, A. 2009. Research Report on Factor Productivity and Marketed surplus of Major Crops in India, Planning Commission, Government of India.

Arnason, R. 2000. Productivity and productivity growth in the Icelandic fisheries, Paper submitted at the conference, Competitiveness within the global fisheries, Akureyri.

Deshmukh, V.D. 2006. Crisis in Fisheries of Maharashtra. National Seminar on Sustainability of Seafood Production: Reflections, Alternatives and Environmental Control. National Institute of Oceanography, Dona Paula, Goa.

Hannesson, R. 2005. SNF working paper No. 24/05. The development of productivity in the Norwegian fisheries, Institute for Research in Economics and Business Administration, Bergen.

Kumar. P. and JHa, D. 2005. Measurement of total factor productivity growth of rice in India: Implications for food security and trade. In Impact of Agricultural Research: Post-Green Revolution Evidence form India (Joshi, P.K., Pal, S., Birthal, P.S., and Bantilan, M.C.S., eds.). New Delhi, India: National Centre for Agricultural Economics and Policy Research; and Patancheru, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics.

Sathiadhas, R., Narayanakumar, R and Aswathy, N, 2012. Marine Fish Marketing in India. CMFRI, Kochi, India.

Sudarsan, D., John, M.E. and Somvanshi, V.S., 1990. Marine Fishery Potential in the Indian Exclusive Economic Zone - An Update. *Bull. Fish. Surv. India*, 20: 1-27.

The World Bank Food and Agriculture Organization and World Fish Center,2010. Conference Edition, 2010. The Hidden Harvests, the global contribution of capture fisheries. Agriculture and Rural Development Department Sustainable Development Network.