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Economic efficiency in fishing operations-Technology, Exploitation and Sustainability Issues

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Introduction

Fisheries sector in India has become a significant part of the economy through its consistent contribution to the GDP –both overall and agricultural-during the last few years, besides serving as vital source of employment and livelihood to millions of people of the country and also earning substantial foreign exchange (About Rs.16,000 crores in 2011-12). Fishing avocation, which was practiced as a means of subsistence in the early century has gradually transformed into a multi crore rupees industry during the last six and a half decades. This development has been made possible through a concerted effort by the stakeholders ably supported by capital investment in the harvest and post-harvest infrastructure both by the private and public sector. The Government supported the sector under various schemes for its development under the various plan periods.

Marine Fishery resources of India

Indian marine fishery resources include an exclusive economic zone (EEZ) of 2.02 million sq.km and a coastal length of 6,068 km. There are 3,288 marine fishing villages and 1,511 marine fish landing centres among nine maritime states and the two union territories of Puducherry and Daman & Diu The revalidated marine fishery resources potential of 3.934 mt is being harvested by a fleet size of 1,94,490 crafts comprising 72,559 (37.3 per cent), mechanized crafts, 71,313 (36.7 per cent) motorized crafts and 50,618 (26 per cent) non-mechanized crafts. (CMFRI, National Marine Fisheries Census, 2010).

The human resource potential of the marine fisheries sector include 8,64,550 families with a total fisher folk population of 39,99,214. Out of the 8.64 lakh fisher folk families, 5.23 lakh are living below povery line (BPL). The number of traditional fisher folk families is 7,89,679 (91.3 per cent of total fishermen families) . (Table 1)

Table: 27.1 Maritime State Profile

State	Coastal length (km)	Landing centres	Fishing Villages	Fishermen families	Traditional fishermen families	BPL families	Fisher folk population
West Bengal	158	59	188	76,981	52,532	48,870	38,0138
Odisha	480	73	813	1,14,238	87,541	56,279	6,05,514
Andhra Pradesh	974	353	555	1,63,427	1,61,039	1,59,101	6,05,428
Tamilnadu	1,076	407	573	1,92,697	1,85,465	1,27,245	8,02,912
Puducherry	45	25	40	14,271	1,424	10,998	54,627
Kerala	590	187	222	1,18,937	1,16,321	65,459	6,10,165
Karnataka	300	96	144	30,713	28,533	23,624	1,67,429
Goa	104	33	39	2,189	2,147	489	10,545
Maharashtra	720	152	456	81,492	74,203	15,509	3,86,259
Gujarat	1,600	121	247	62,231	59,469	15,784	3,36,181
Daman &Diu	21	5	11	7,374	7,181	333	40,016
Total	6,068	1,511	3,288	8,64,550	7,75,855	5,23,691	39,99,214

Source: CMFRI, National Marine Fisheries Census, 2010 India, p.27

Marine fish production

The marine fish production in India increased from 14.30 lakh tonnes in 1985 to 38.30 lakh tonnes in 2011. The landings by the mechanized sector increased from 9.52 lakh tonnes in 1985 to 30.07 lakh tonnes, motorized sector's landings increased from 1.30 lakh tonnes to 7.29 lakh tonnes, while that of the non-mechanized sector declined from 3.48 lakh tonnes to 0.94 lakh tones during the same period. (Table 2)

Table: 27.2 Sector-wise marine fish landings in India 1985-2011 (lakh tonnes)

Year	Mechanised	Motorised	Non-mechanised	Total landings
1985	9.52	1.30	3.48	14.30
1990	13.11	4.48	3.04	20.63
1995	14.93	4.44	2.04	21.41
2000	16.82	6.67	2.04	25.53
2005	15.21	5.92	1.03	22.16
2006	18.52	6.47	1.25	26.25
2007	18.95	7.95	1.13	28.03
2008	22.70	7.43	1.19	31.33
2009	23.59	6.84	0.93	31.36
2010	26.07	6.44	0.68	33.19
2011	30.07	7.29	0.94	38.30

Source: FRAD, CMFRI, 2011

In terms of per cent share also the mechanized sectors contribution to the total landings increased from 66.56 per cent in 1985 to 78.51 per cent in 2011. The motorized sectors' share in the total landings also increased from 9.10 per cent to 19.04 per cent while that of the non-mechanized sectors' share declined from 24.34 per cent to 2.45 per cent between 1985 and 2011. (Table 3)

Table 27.3 Sector-wise marine fish landings in India 1985-2011 (per cent)

Year	Mechanised (per cent)	Motorised (per cent)	Non-mechanised (per cent)	Total landings (per cent)
1985	66.56	9.10	24.34	100.00
1990	63.53	21.72	14.75	100.00
1995	69.74	20.74	9.52	100.00
2000	65.89	26.13	7.98	100.00
2005	68.63	26.72	4.65	100.00
2006	70.58	24.65	4.77	100.00
2007	67.61	28.36	4.03	100.00
2008	72.47	23.73	3.81	100.00
2009	75.23	21.80	2.97	100.00
2010	78.54	19.40	2.06	100.00
2011	78.51	19.04	2.45	100.00

Growth of marine fishing units in India

The overall trends in growth o fishing units during the last five decades indicate the possible phasing out of non-mechanized canoes at least in certain regions, which ultimately reflected a negative growth rate of 51 per cent between 2005 and 2010. The total marine fishing fleet has in fact declined from 2,38,772 in 2005 to 1,94,490 in 2010, registering a decline of 19 per cent. While the number of non-mechanised (51 per cent decline) and motorized (6 per cent decline) declined between 2005 and 2010, the mechanized boats alone registered an increase of 23 per cent (from 58,911 in 2005 to 72,559 in 2010(Table 4). There is a shift towards mechanized fishing units by the fisherfolk due to their higher mobility, stability and technical efficiency. This increase in mechanized boats may be further attributed to the assistance provided for the purchase of crafts by different government and non-government agencies including the tsunami rehabilitation measures. When the technical efficiency of a particular gear is better than the other, the lesser efficient gears gradually disappear from the operation (Sathiadhas, 1998).

Table 27. 4 Growth rate of marine fishing fleets in India 1961-62 to 2010

Year	Non-mechanized		Motorized		Mechanized		Total	
	Number	Growth (per cent)	Number	Growth (per cent)	Number	Growth (per cent)	Number	Growth (per cent)
1961-62	90,424	-	0	0	0	0	90,424	0
1973-77	1,06,480	18	0	0	8,086	0	1,14,566	27
1980	1,37,000	29	0	0	19,013	135	1,56,013	73
1998	1,60,000	17	32,000	0	47,000	147	2,39,000	53
2003	76,596	-52	50,922	59	49,070	4	1,76,588	-26
2005	1,04,270	36	75,591	136	58,911	25	2,38,772	35
2010	50,618	-51	71,313	-6.0	72,559	23	1,94,490	-19

Source: Sathiadhas, 2009

Economic performance of marine fishing methods

The analysis of the economic performance of fishing methods is assessed by working out the fixed cost, operating cost per trip, gross revenue per trip, net operating income per trip and annual net income through **tabular analysis**. The capital and labour productivity are also worked out using operating ratio and catch per labour per trip respectively to assess the economic performance

The annual fixed cost comprises the depreciation on fishing equipment including the crafs, gears and other accessories, annual tax levied, annual wage paid to any permanent employee in the craft, interest on fixed capital and insurance premium paid.

The operating cost per trip (also known as variable cost) is calculated as follows

VC/trip = {(Fuel + Crew wage + Food + Auction + Other charges)}…..(1)

The gross revenue per trip is calculated from the species composition of the catch and price per unit. The gross revenue per trip is thus estimated as follows

$$\text{GR per trip} = \sum_{i=1}^{n} q_i p_i \quad \ldots\ldots(2)$$

where, q_i is the quantity of catch in kg of the i^{th} variety
p_i is the price per kg of fish of the i^{th} variety

Case studies

Our Division is conducting the research projects on the economic analysis of marine fishing methods across the selected centres along the coast of India. A glimpse of their findings are given below to understand the concept.

In BV Palem, Andhra Pradesh, the average operating cost per trip of the **single day trawl** fishing worked out to Rs.8,572 per trip earning a gross revenue of Rs.22,941 with a net operating income of Rs.14,369 per trip. Fuel accounted for 57 per cent of the total operating cost followed by crew wages 27 per cent.

In Kakinada Fisheries Harbour, the average operating cost per trip of the **single day trawl** fishing worked out to Rs.8,258 per trip earning a gross revenue of Rs.21,238 with a net operating income of Rs.12,980 per trip. Fuel accounted for 57 per cent of the total operating cost followed by crew wages 25 per cent

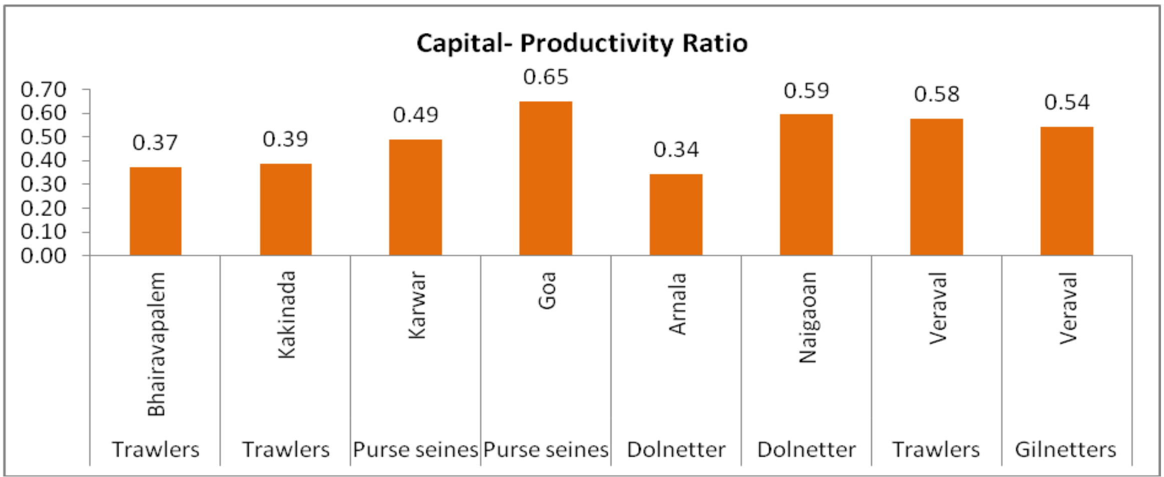

Figure 27.1 Capital productivity Ratios of Single Day Operations

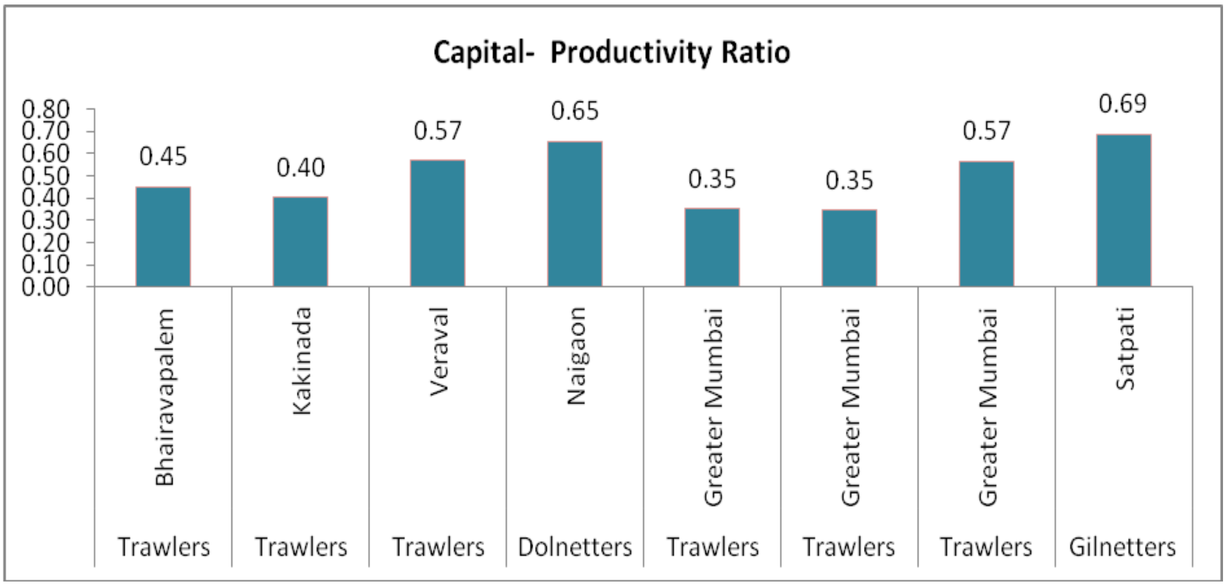

Figure 27.2 Capital productivity Ratios of Multi-day Operations (2-5 days)

Economic Efficiency measurement concepts

` Farrell (1957) proposed that the efficiency of a firm consists of two components namely technical efficiency and allocative efficiency. The technical efficiency reflects the ability of the firm to obtain maximum output from a given set of inputs, while the allocative efficiency reflects the ability of the firm to use the inputs in optimal proportions, given their respective prices. These two measures are then combined to provide a measure of total economic efficiency.

The efficiency of resource use has been studied by many methods. The simple yield or return per unit or costs per unit have been used earlier in efficiency studies to compare the different firms or decision-making units. However these methods do not mention how much of the difference in efficiency is due to the amount of or ratio of inputs used and related effects.. Coelli (2002) highlighted the problems of using the simple measures for comparisons and also indicated that such measures do not tell anything about the existence or otherwise of scale economies. To avoid these problems he attempted constructing non-parametric production frontiers using data envelopment analysis (DEA) method. The parametric method can be estimated using frontier production method.

The technical efficiency (Timmer's measure) of multi-day trawl fishing (2-5 days) operated from Visakhapatnam centre is given below.

Table 27.5 Technical efficiency of multi-day trawl fishing, Visakhapatnam 2010-11

Efficiency Level	Frequency of the operators	Percent	Cumulative per cent
Less than 0.2	4	3.85	3.85
0.21 -0.30	22	21.15	25.00
0.31-0.40	50	48.08	73.08
0.41-0.50	17	16.35	89.42
0.51-0.60	3	2.88	92.31
0.61-0.70	3	2.88	95.19
0.71-0.80	1	0.96	96.15
0.81-0.90	2	1.92	98.08
0.91-1.00	2	1.92	100.00
		100.00	

Thus it can be seen that abut 90 per cent are operating with 50 per cent efficiency and there is some scope to increase the efficiency of operation.

Sustainable fishing and development

Sustainable development

Generally sustain refers to keep up continuously without any interruption or disturbance. "Sustainability refers to the simple principle of taking from the earth only what it can provide indefinitely, thus leaving future generations no less than we have access to ourselves."

Sustainability is viewed differently from the point of view of ecology, economics and sociology.

- From the ecology point of view, it is the ability of ecosystems to maintain its structure and function and to remain resilient in order to continue to give and support life.
- From economic angle, the sustainability refers to the ability of the market to optimally allocate scarce resources, to send proper price signals and to provide mechanisms for investment and to maintain a healthy labour market.

- For a sociologist, it refers to the ability of individuals and communities to remain in good health physically, mentally, emotionally and spiritually and ensure equity among and between generations.

The definition sustainable development given by the World Commission on Environment and Development (1987) is taken as the guide line for the sustainable development now. "**Sustainable development is that Development that meets the need of the present generation without compromising the ability of future generations to meet their own needs"** This definition of sustainable development is widely accepted and commonly used world-wide.

Since the definition of sustainable development in 1987 by the Brutland Commission report followed by extensive discussion, **there dimensions of sustainable development** have emerged.

1. **Economic dimension**: An economically sustainable system must be able t produce goods and services on a continuing basis, to maintain manegable levels of government and external debt, and to avoid extreme sectoral imbalances, which damage agricultural or industrial production
2. **Environmental Dimension:** An environmentally sustainable system must maintain a strong and stable resource base, avoiding over exploitation of renewable resource systems or environmental sink functions and depleting non-renewable resources only to the extent that the investment is made in adequate substitute. This includes maintenance of biodiversity, atmospheric stability and other ecosystem functions not ordinarily grouped as economic resources.
3. **Social dimension:** A socially sustainable system must achieve distributional equity, adequate provision of social services including health and education, gender equity and political accountability and participation.

Sustainable Fisheries Yield

Fisheries are classified under renewable natural resources. However such resources are also liable to become extinct if the rate of harvest or exploitation is higher than the rate of regeneration or reproduction. Here the size of the stock (population) depends on the biological, economic and social considerations.

The sustainable yield in fishing commonly referred to as "Maximum Sustainable Yield (MSY) is a biological phenomenon. MSY means that level of fish catch or yield that can be harvested from a given system in perpetuity without affecting the stock of the system (or the sea). In other words, a catch level is said to be sustainable whenever it equals the growth rate of the population since it can be maintained for ever. As long as the population size remains constant, the growth rate will remain constant as well.

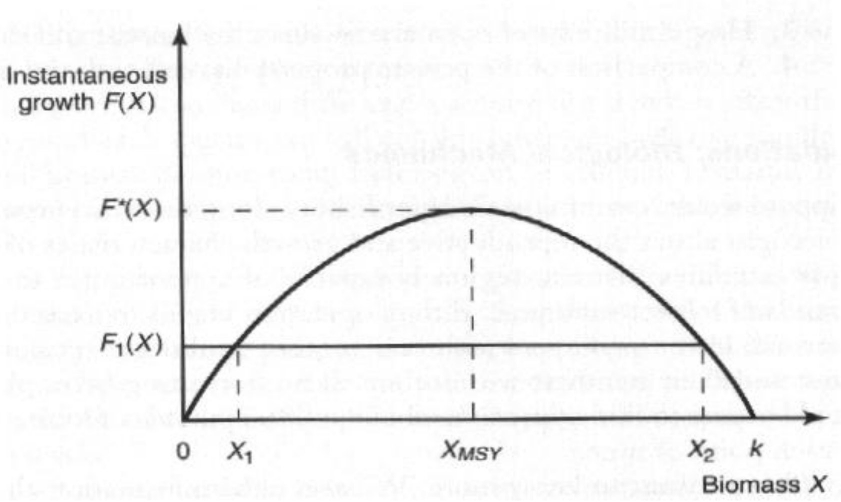

Figure 27.3 Sustainable Yield Curve

Source John A. Dixon, Fisheries and Aquatic Resources World Bank Institute

There is an additional concept called Maximum Economic Yield (MEY) which includes the monetary terms of the effort and returns.

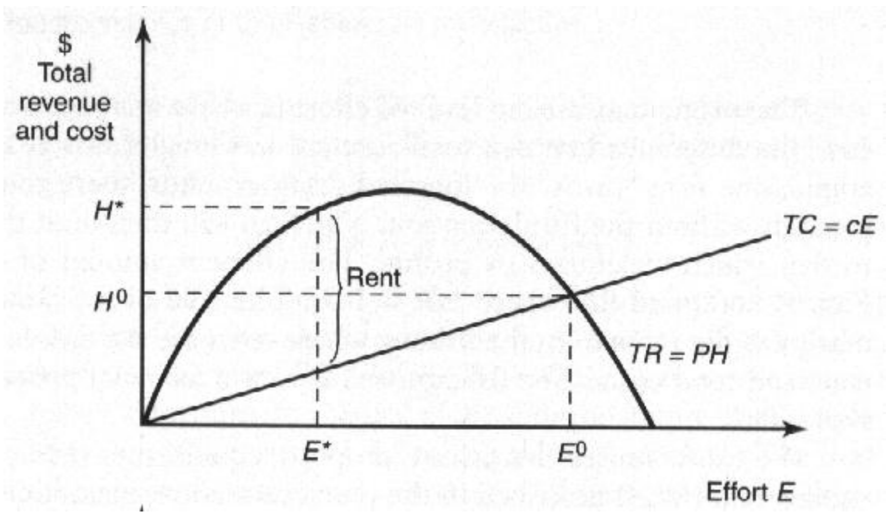

Figure 27.4 Maximum Economic Yield

When the relationship between effort and money are measured, it was observed that when stock is low, effort must be high.

- Total revenue (*TR*) = Price (*P*) × Catch (*H*)
- TC = Unit cost (*c*) × Effort
- Rent = TR – TC

The rent is maximized at the point E*. Here

- *MEY* is left of *MSY*
  - Optimal harvest (*H**) is less than the *MSY* harvest
  - But rent is larger than at *MSY*

The marginal analysis can show that the MEY occurs at the point where MC =MR. It is observed that for marginal unit of effort, marginal rent is = 0 and average rent >1.

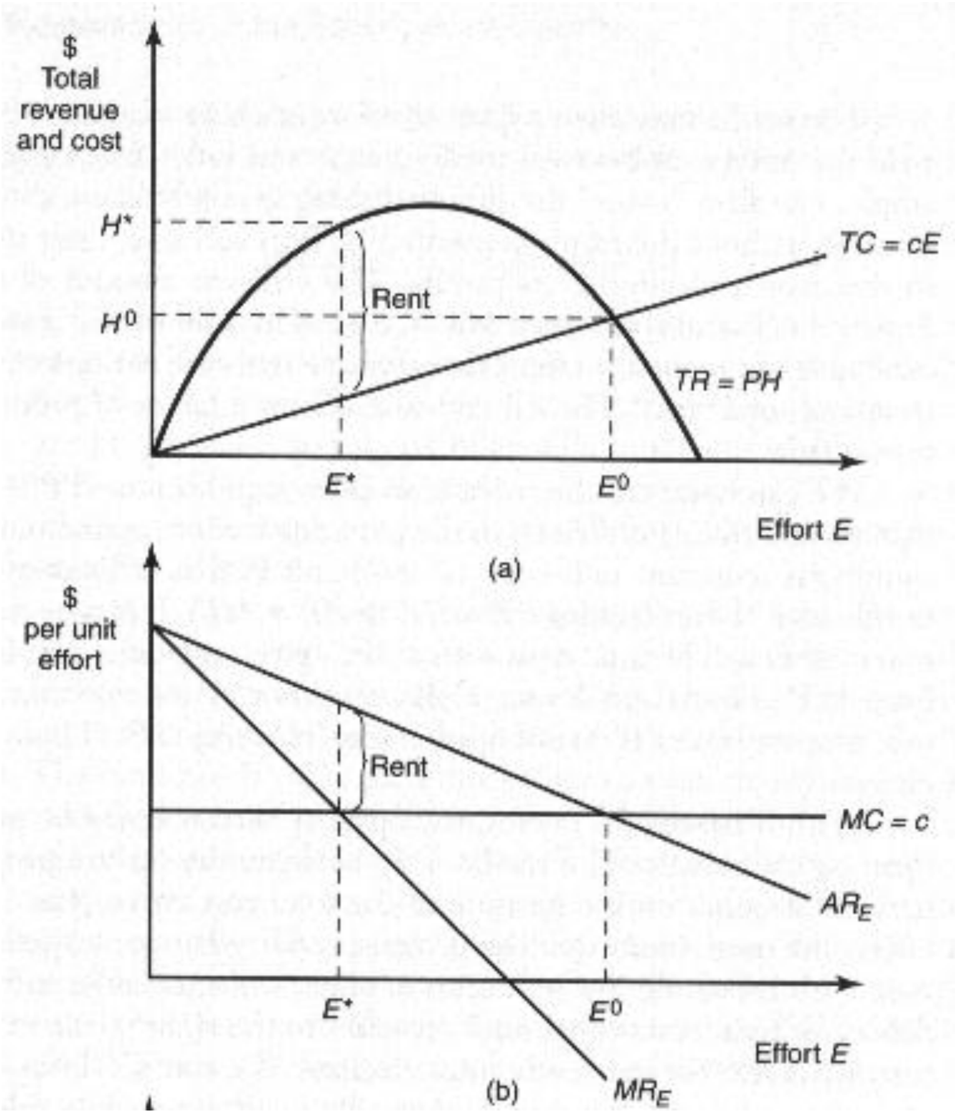

Figure 27.5 : Revenue Cost Effect relationships

Dixon concludes that the "Goal of traditional fisheries management: achieve *MSY.* However the economists aim for MEY in contrast to MSY. AT MEY, compared to MSY, the fish catch is lower, fishing profit is higher, fishing effort is lower and the fish stock is higher. Thus the author concludes that MEY is where more fish is conserved. (Dixon, 2005)

Technology, exploitation and sustainability issues

The marine fishing sector has witnessed vast technological developments in both harvest and post harvest fisheries during the last few decades. The investment in fishing sector is mostly private capital formation with government's participation coming up in ports, harbours and similar major infrastructure. Now what are the issues that are likely to arise?

First, the basic economics of operation. Whether the economics of fishing operations are profitable in India now? The answer is both yes and no but mostly a positive response. Unless there is some income, no one will invest in this venture. IF you compare the census figures, the mechanized crafts have increased between 2005 and 2010 (23 per cent), which may be taken as an indicator of profitability.

Second the encouragement received from the seafood trade front also prompts the fisher folk to remain in the industry. The consistent export earnings has given a sense of support to the fishers to get assured that their fish are being purchased atleast a little higher price than that of the domestic market. The recent trend of increasing fin fish exports in the seafood basket is a testimony to this.

Third the concept of sustainability needs a serious thinking. Whether the export has led to indiscriminate harvest of targeted harvest of a few species needs to be analysed critically. Already a few researchers have started asking whether India needs to export seafood at all? What is the impact of seafood export in the domestic market?

Fourth point is the impact of sea food export on the socio economic conditions of the million fisher folk,who depend on the industry especially seafood industry. Whether they are earning a sustainable income or fluctuating income. How the seafood export can safeguard their livelihood?

Thus the economics of fishing operations needs to be studied in total with the sustainability and technological issues to arrive at a comprehensive evaluation of the economic performance of the fishing operations in India.

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