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EFFECT OF DECLINING OIL SARDINE LANDINGS ON THE LIVELIHOODS OF TRADITIONAL FISHERS IN KERALA

Shyam S. Salim*, K. Sunil Mohamed, Safeena P.K. and Remya R.

ICAR- Central Marine Fisheries Research Institute, Kochi

ABSTRACT

The Indian oil sardine, *Sardinella longiceps* is a very important pelagic fish species which contributes to about 25% of the total marine fish production in India. The oil sardine contribution slipped to an all-time low of about 68,431 tonnes during 2015. Unfavourable environmental impact caused by the El Nino appears to have played a powerful role in the slump of oil sardine fishery. There have been considerable losses in the income and number of employment days. The losses are contributed not only by reduction and reduced catches but also reduced number of fishing operations and fisher man days. The present study probes with the following objectives viz., assessing the share of different crafts and gears harvesting oil sardine over the years, estimating the quantum of losses consequent to reduced landings and efforts and assessing the impact on reduction in landings on employment. The analysis revealed that the average employment loss during 2015 was estimated as 129.84 crores and the wage loss as 104.58 crore. The total economic loss incurred to the fishermen was found to be 234.42crores. The constraints expressed by the fishers indicated that reduced income and increased employment and increased debts were the major impending factor for the reduced landings of sardine. The study highlights the need for governmental guidelines in demarcating areas for sardine catches for the traditional fishermen so that the livelihood isn't affected and would reduce fishing pressure from other sectors

***Corresponding author e-mail:**
shyam.icar@gmail.com

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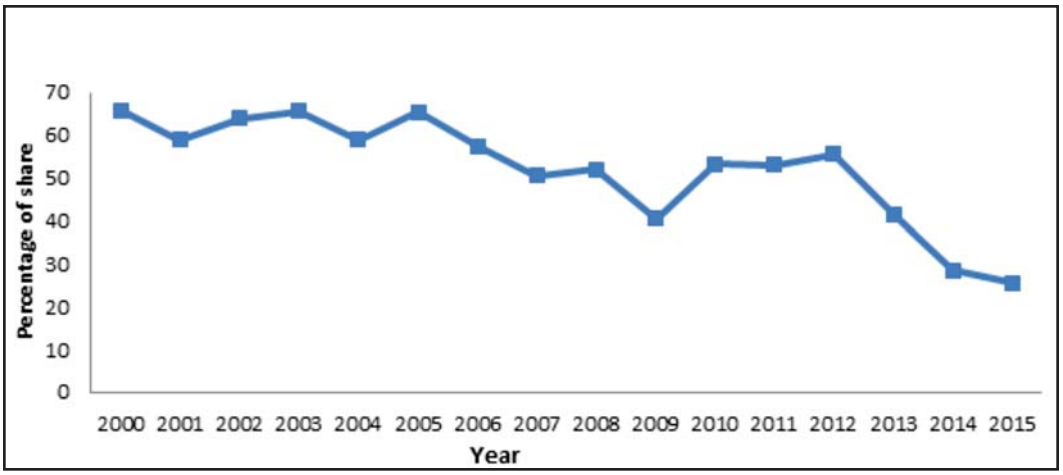
Introduction

Marine fisheries contribute to food security and provide direct employment to over 1.5 million fisher people besides others indirectly dependent on the sector. The Indian oil sardine, *Sardinella longiceps* is a very important pelagic fish species which contributes to about 25% of the total marine fish production in India. The total fish landings in this country during 2015 is 3.40 million tonnes out of which oil sardine contribution is about 2.68 lakh tonnes (CMFRI, 2015). Kerala contributed the

maximum oil sardine as high as 65% during 2000, 2002 and 2005, however the contribution slipped to an all-time low of about 68,431 tonnes which implies that the share is only 25% during 2015(Figure.1) . Sardines contributed almost 52.54% of the total pelagic share during the quinquennial period (2010-2015) along Kerala (Fig. 1). In addition sardine accounts for more than 30 per cent of the fish consumption basket of Keralites ensuring fish food security of the states populace (Shyam, 2013).

Fig.1 Share of Oil sardine landings in Kerala to total



There has been a decrease of about 16% in all Kerala marine fish landings during 2015 when compared with the previous year. Sardine is caught by various gears like mechanised ring seine, outboard ring seine, non-mechanised, mechanised purse seine, outboard gillnet and others. The total sardine catch in Kerala during 2015 was 78,721 t of which oil sardine accounted for 86.9% (68,431 t) and the other sardines accounted for 13.1% (10,290 t). Oil sardine catch along Kerala coast declined drastically to 68,431t registering a sharp decline from an estimated 1.55 lakh t recorded in the previous year and a record of 3.92 lakh t during 2012. Unfavourable environmental impact caused by the El Nino appears to have played a powerful role in the slump of oil sardine fishery.

Oil sardine grows rapidly during the first few months and matures early within its life span of about two and a half years. The age at first maturity occurs at less than one year, at about 150 mm size. Maturation is controlled by climatic factors like temperature and intensity of rainfall experienced by the pre spawners. The oil sardine is a planktivore and diatoms, dinoflagellates and copepods are the favoured food items. The optimum temperature and salinity ranges for distribution and abundance of oil sardine is 27-28° C and 22.8-33.5ppt, respectively although occasionally they have been observed to enter the estuaries along the southwest coast. The El Nino phenomenon that might be directly or indirectly influenced by the 11-year solar activity cycle and manifested with an abnormal increase in sea temperature and related changes in hydrographic parameters may also be considered partly responsible for fluctuations in its abundance. Therefore, the size and time of appearance of oil sardine shoals and studies on climatic and

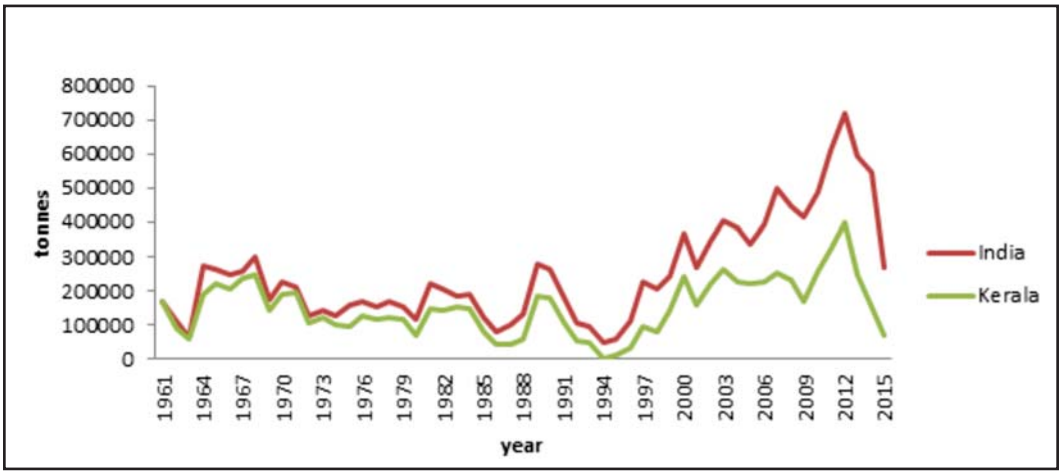
hydrographic parameters in relation to spawning biology can all be meaningfully employed in predicting the fishery.

Sardine accounts for more than 30 per cent of the fish consumption basket of Keralites ensuring fish food security of the states populace (Shyam, 2013). Besides being a favoured, nutritionally rich and affordable table fish occurring abundantly almost throughout the year, it also serves as a source of valuable by-products like sardine oil used in several industries and fish-meal for cattle and poultry feed production (Shyam *et al*., 2015). Its fishery is characterised by remarkably wide fluctuations on a seasonal, annual and decadal scale. The successful years of oil sardine fishery bring much prosperity to the fishing community and its failure a major economic setback.

Oil sardine landings over the years

Until 1985, almost the entire catch of *Sardinella longiceps* was from the Malabar upwelling zone and the catch was either very low or there was no catch from latitudes north of 14°N along the west coast. It is a remarkable feature that Kerala being the largest oil sardine yielding state, its sardine landings in relation to the total marine catches to a great extent reflected a mirror image of the all-India oil sardine catch trend during the period from 1956 to 1983 (Balan, 1984). It was after 1980s that the *Sardinella longiceps*e merged as a major fishery along the southeast coast, with the annual catch recording more than one lakh t. In the last two decades, however, the catches from latitude 14°N - 20°N are consistently increasing, contributing 25% of the total marine fish production in India. The surface waters of the Indian seas are warming by 0.04°C per decade, and the warmer tongue (27-28.5°C) of the surface waters is expanding to latitudes north of 14°N enabling the oil sardine to extend their distributional range to northern latitudes (Vivekanandan *et al.,* 2009). Widely fluctuating trends have been observed in the landings of the oil sardine right from the early years for which catch statistics are available (Fig.2).

Fig.2 Oil sardine landings (India vis-à-vis Kerala)



The landings have declined from 5.45 lakh tonnes in 2014 to 2.67 lakh tones in 2015 (CMFRI, 2015). The southwest region comprising the states of Kerala, Karnataka and Goa where oil sardine was abundant, experienced a major setback resulting in the overall reduction of oil sardine landings in the country with a maximum loss of nearly 3 lakh tonnes. However, these falloffs in the landings are not very unusual as, the oil sardine stock has collapsed in a similar way in 1929, 1943, 1963, 1986 and as recently as 1994. Millions of this small fish are highly influenced by the environmental conditions in the sea, the temperature, salinity, oxygen levels etc. Primarily, it is the timing that is important, when the sardine babies are born; there should be enough planktonic food in the sea. After 2012, there have been serious disruptions in the timing and strength of environmental events like upwelling in the Arabian Sea. Besides, 2015 was a strong El Niño year with reduced rainfall and increased sea surface temperatures. These, coupled with excessive fishing on the stock beyond the maximum sustainable yield, and excessive capture of juveniles during 2010-2012, has led to a "famine" in the oil sardine stock in the Arabian Sea off Kerala.

Problem focus

From the above figure, it could be observed that oil sardine is mainly contributed by gears which are mostly traditional, motorised or non-mechanised. Consequent to the share decrease during the period, there has been considerable losses in the income and number of employment days. The losses are contributed not only by reduction and reduced catches but also reduced number of fishing operations and fisher man days. Therefore, the present study probes with the following objectives *viz.*, assessing the share of different crafts and gears harvesting oil sardine over the years, estimating the quantum of losses consequent to reduced landings and efforts and assessing the impact on reduction in landings on employment.

Material and Methods

The time series data on estimated oil sardine landings, the fishing effort expended in terms of units and hours of operation of different crafts involved in catching oil sardine, the average crew size and fishing trips per year were collected from the National Marine Living Resources Data Centre (NMLRDC) of the Central Marine Fisheries Research Institute, kochi for the period during 2006-15. The prices data were obtained from SEETTD and were deflated to arrive at real prices for meaningful comparison. The fishers' perceptions regarding the losses they have incurred were obtained from 60 fishermen across Ernakulam and Kozhikode district were interviewed using a structured survey schedule. The economic losses was estimated as the sum of the employment losses and wage losses during the period.

Total economic loss (TEL_{2015}) = Employment loss during 2015(EML_{2015}) + Wage loss during year 2015 (Wl_{2015})

$$TEL_{2015}=EML_{2015}+WL_{2015} \quad \text{(I)}$$

$$EML_{2015}=\frac{\sum_{i-2006}^{2014}(EM_i - EM_{2015})* PCW_i}{n} \quad \text{(II)}$$

$$WL_{2015}=EM_{2015}*(PCW_{2015}) \quad \text{(III)}$$

Where

TEL_{2015} - Total economic loss

EML_{2015} -Employment loss during 2015

Wl_{2015} - Wage loss during year 2015

Em_i - Number of employment opportunities in the year I

Em_{2015} - Number of employment opportunities in the year 2015

PCW_i -Per capita wage in the year I

PCW - Average per capita wage during the year 2006-14

n -the number of years

Results and Discussion

The results are discussed under the following heads.

a) Assessing the share of different crafts and gears harvesting oil sardine

Oil sardine is mainly caught by the traditional fishermen and acts as mainstay for 1.1 lakh fishermen families of Kerala. These fishers use different kinds of seine nets from traditional to modernised crafts to catch the fish schools. Over the period of time the traditional fishermen decimated on account of larger number of boats and lower share of catch. Fishing effort by ring seines increased steadily till 2012 due to its horizontal spread along the entire coast. Thereafter, it declined due to low catch and catch rates, which made their operation economically non-viable. Both production by gear and their contribution to the state's total landings registered a sharp down trend after 2012, due to the probable collapse in oil sardine fishery. During the period 2005 and 2015, outboard ring seine (OBRS) contributed the major share followed by mechanised ring seine (MRS), non mechanised (NM), outboard gillnets (OBGN) and others (Fig. 3), whereas, during 2010, mechanised ring seine contribution was larger when compared to outboard ring seine (Fig 3).

Ring seines (mechanised and outboards) contribute to the major share of landings of oil sardine. While comparing the percentage of oil sardine catch over the years across various gears it was observed that about 96% of the sardine catch was recorded from ring seines during 2010 which declined by 93% during 2015 and 87% during 2005. There was considerable reduction in landings during 2015 when compared to the previous years. Even though the landings were poor in 2015, the increase in the contribution of oil sardine to the ring seine shows the significance of this gear to the overall contribution in the sardine economy.

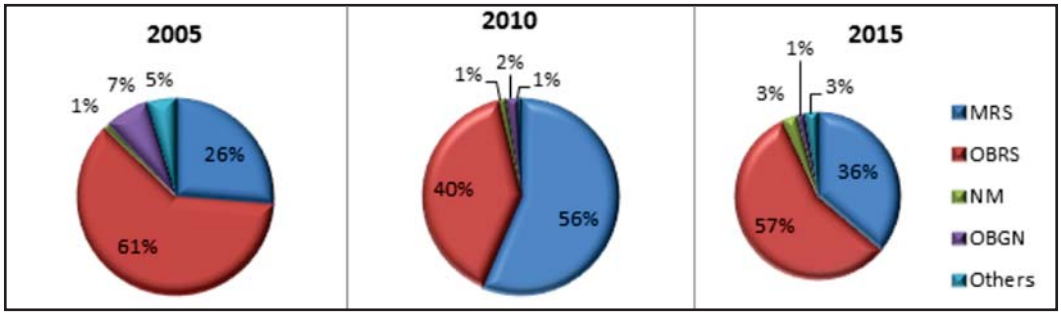
Economic losses

Numerous economic losses have been found consequent to the reduced landings of the sardine. These economic losses arose due to the reduction in the operation, lower levels of employment days and limits to wage rate (crew share) realisation resulting in considerable income loss.

b) Estimating the economic losses in terms of reduced employment and lower wage realisation

The total economic losses were computed as the sum of employment and wage losses. The assessment of the quantum of losses to the fishermen community on account of reduced sardine landings over the years was computed using the following equation

Fig.3. Catch composition across craft and gear over the periods



Total economic loss (TEL_{2015}) = Employment loss during 2015(EML_{2015}) + Wage loss during year 2015 (WL_{2015})

Employment losses

The employment losses were computed based on the number of trips per year, crew size and fleet in operation. The average number of trips per year for MRS, OBRS, NM and OBGN were found to be 120, 200, 240 and 60 respectively. The average number of crew size was estimated as 25, 25, 3 and 5 for MRS, OBRS, NM and OBGN respectively. The fleet size was 435 for MRS, 728 for OBRS, 1680 for NM and 10265 for OBGN (Table 8). The reduction in sardine landings resulted in reduced number of employment opportunities which came down from 130.21 (2012) to 88.33 lakhs during 2015 (32%)(Fig 55). Most of the fisher families survived on the income earned by other women family members during this period.

Wage losses

Wages were calculated based on CPUE, labour share, landing centre price and crew size and is presented in table 8 The average CPUE for the period 2006-2014 for MRS, OBRS, NM and OBGN was found to be 1911, 811, 8 and 2 kg/unit operations respectively. For the period 2015, there was a reduction in CPUE for MRS and OBRS with an average of about 843 and 339 kg/unit operations respectively when compared with 2006-14. For NM and OBGN the values were found to be 8 and 2 kg/unit operations respectively. The average labour share for ring seine, non-mechanised and motorised during 2006-15 was found to be 40, 80 and

Table8. Catch and other details of the sardine fishery which were used in the analysis and the results

Parameters /Gear	MRS	OBRS	NM	OBGN
Average number of trips per year	120	200	240	60
Average number of crew size	25	25	3	5
Average fleet size	435	728	1680	10265
Average CPUE for the period 20016-2014	1911	811	8	2
Average CPUE for 2015 (kg per unit)	843	339	8	2
Reduction in employment opportunities in 2015 in man-days (lakhs)	From 130.2 - 83.3 -32% (loss in employment)			
Average landing centre price for the period 2006 -2014 (Rs. / kilogram)	28			
Average landing centre price for the period 2015 (Rs./ kilogram)	65			
Wages during 2006-14 (Rs.) Per person / day	467.4			
Wages during 2015 (Rs.) Per person / day	349.0			
Average employment loss during 2015 (man days)	129.8 crores			
Average wage loss during 2015 (Rs.)	104.6 crores			
Total economic loss (Rs.)	234.42 crores			

MRS- Mechanised Ring Seine , OBRS- Outboard Ring Seine, NM- Non Mechanised
OBGN- Out Board Gill Netters

60% respectively. The average landing centre price of oil sardine for the period 2006-2014 was found to be Rs.28 which has increased to about Rs.65 in 2015. The average daily wages of workers have come down from Rs.467.44 during 2006-14 to Rs.349.04 during 2015 (25%).

Total Economic loss

The average employment loss during 2015 was estimated as Rs. 129.84 crores and the wage loss as Rs104.58 crores. The total economic loss incurred to the fishermen was estimated at Rs. 234.42crores

c) Fishers perception on the effect of reduced sardine on their livelihood

The fishers opinion regarding the reduction in landings and its aftermaths on their livelihood were collected using a pre-structured questionnaire. A total of 100 fishermen along Thiruvananthapuram, Alappuzha and Ernakulam districts of Kerala were interviewed to know their response due to sardine reduction. The constraint analysis was done on the based on the opinion of the fishers. The major constraints perceived by them were analyzed using Garrett ranking and the ranks with score are presented in Table 3. The Garrett's ranking technique is usually used to rank the preference indicated by the respondents on different factors. The ranks assigned by the respondents for different factors are converted into scores.

$$\text{Percept position} = \frac{100\ (R_{ij}-0.5)}{N_i}$$

Where, R_{ij}= Rank given for the i^{th} variable by j^{th} respondents, N_j=number of variable ranked by j^{th} respondents

The constraints expressed by the fishers indicated that reduced income and increased employment and increased debts was found to be the major impending factor due to the reduced landings of sardine. Some of the fishers also opined that the unemployment would also lead towards forced migration adding to health concerns and stress and strain.

Conclusion

The study has indicated that fishermen share of oil sardine landing in the traditional sector has considerably decreased over the years. Sardine is no longer a catch in the non-motorised /non mechanised sector. It is being showing its occurrence in the mechanised sector also. The fishermen income has got reduced, debts increased, so the estimated losses on account of disguised unemployment and revenue losses are estimated as 234.42crores. The present landings of Sardine showed similar landing behaviour in 1994 all of which would lead to Sardine famine which will further aggravate the employment, income and livelihood of the fishers. So it is imperative for the government to add guidelines in terms of

Reason	Score	Rank
Reduced income	91.67	I
Increased Unemployment	75.00	II
Need for migration	41.67	IV
Increased debts	58.33	III
Health concerns	25.00	V
Stress and Strain	8.33	VI

demarcating areas for sardine catches for the traditional fishermen so that the livelihoods isn't affected and would reduce fishing pressures from other sectors. With increasing debts and burdened by economic losses, appropriate government measures may be enacted to waive for loans and to provide for appropriate welfare measures.

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