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Deep-sea shrimp fishery operations in Kerala coast: Problems and Prospects

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Abstract
Deep-sea shrimp fishery operations in Kerala were initiated since 1999 with high landings which subsequently dropped considerably. The present study assesses the different problems faced by trawl-operators in deep-sea shrimp fishing operations. High operational cost, high risk and efforts, lack of skilled and trained manpower, low market price realisation, abundance of discards, poor quality of shrimps, low level of harvesting technology perceived a major hurdles in deep-sea shrimp fishery sector. The study suggests the need for improved governmental support in deep-sea operations for the sustenance of the sector in ensuring fish food security for the Kerala populace.

Keywords: Deep- Sea, shrimp fishery, economic efficiency, Issues, bycatch.

1. Introduction
Fish and fish products is one of the world's most widely traded foods and play a pivotal role in the global food economy. They constitute an important sector in many maritime nations not only as a major food source but also as a generator of forex earnings and employment. Fish contributes 17 percent of the global population's intake of animal protein and provides essential minerals, vitamins and omega -3 fatty acids [1]. Fisheries sector play as a source of employment for more than 200 million people in worldwide [2]. In comparison to other sectors of the world food economy, however, the fisheries and aquaculture sectors are poorly planned, inadequately funded, and neglected by all levels of government [3].

Fishery sector continues to be one of the fastest growing food sectors in the country in addition to the aquaculture. The current level of fish marine production in India is around 3.94 million tones [4]. Kerala contributes a large share to national marine fish production and generates around 8 lakhs tone of fish annually with sizeable contribution by pelagic fishes (73 percent) and demersal fishes (16 percent), crustaceans (6 percent) and molluscan (5 percent) resources. The per capita fish consumption in Kerala found to be 27 kg/ year and it crosses the national average [5].

Even though their normal little size, shrimps collectively represent the biggest and most valuable seafood commodity traded worldwide. Over the last two decades worldwide production of shrimp has increased exponentially and accounts for 16 percent of global seafood exports [1]. The shrimps occupy a prominent position in the economy of India on account of its high export value among the marine fishery resources of the nation. During the year 2012-13 the shrimp export generated the value of 8833.29 crores from an export quantum of 2.09 lakh tonnes [6]. In addition domestic shrimp consumption is on the rise with increased consumer willingness to pay for shrimp across the different consumption centers [7].

The marine fishing sector has witnessed vast technological developments in both harvest and post-harvest area during the last few decades. Globally capture fisheries faced by many issues and poor economic returns is one of the major problem. Economic research in the field of fisheries assumes a main part for forecasting appropriate policy measures and planning the future development schemes. In India all types of fishing units on an average run on profit as their earnings exceed, the break-even point mainly due to favourable price trend and even if due to nature of competition of open access marine fisheries, some of the less efficient units belonging to each category are forced to go out of the sector due to losses [8].

Deep-sea fishes are considered as one of the promising resources for the future, as coastal fishery alone cannot ensure the nutritional requirement of the population. In India deep-sea fisheries sector is not well developed probably due to lack of awareness among fisher folk, poor governmental support together with shortfall of expertise. The current level of commercial exploitation of deep-sea resources is limited only to deep-sea shrimps and deep-sea sharks [9]. During the recent years the non-availability of fish as a result of reduced catches and increased demand in national and international market coupled with increasing price, leads to a situation to harvest and harness the new fishery resources to meet the demand and supply relationship [10]. The commercial fishery of deep-sea shrimps began in Kerala since 1999 using smaller and medium conventional trawlers [11]. The number of deep-sea shrimp trawlers increased rapidly within one year and fishery were reported from more than ten landing centers. Landing peaked in 2000-2001 and then dropped significantly in the following years [12]. In India, Studies on fishery, catch, species composition and biological aspects of deep-sea shrimps reported mainly from Kerala, Karnataka and Tamil Nadu coast [13-16]. The present study emphasizes the importance of addressing the issues faced by this sector with at most priority to improve economic efficiency and there by contribute towards sustainable management and development of deep-sea shrimp fishery in Kerala.

2. Materials and methods

A structured survey schedule was developed, pilot tested which solicited information's details on craft and gear, capital investment, fixed cost, operational cost, catch , species composition and revenue.The data was collected from 90 trawl operators (owners and labourers) operating in Sakthikulangara (Kollam district), Vypine and Cochin Fisheries Harbours (Ernakulam district) of Kerala State, during the period August 2010- May 2011. Percentage and tabular analysis was done to analyse the economics of deep-sea shrimp fishing operations.

In order to assess the different problems perceived by the trawl owners and fishermen the Garette Ranking Technique [17] was employed to rank the problems in deep-sea shrimp fishing as expressed by the trawl owners and labourers. The order of merit given by the trawl owners was transmitted into scores. For converting the scores assigned by the trawl owners and labourers towards the particular problem, percent position was worked out using the formula.

$$\text{Percent Position} = 100 (R_{ij} - 0.05)/ N_j$$

Where,

R_{ij} = rank given for the i^{th} problem by the j^{th} trawl operator

N_j = number of attributes

The primary purpose of this methodology employed was to collect qualitatively accurate data than quantitative data, with a view to being able to put forward advisory and management strategies based on reliable information.

3. Results and Discussion

3.1 Economic evaluation of fishing operations

The primary data on craft and gear, capital investment, fixed cost, operational cost, catch, species composition and revenue was collected to analyse the economic efficiency of deep-sea shrimp trawlers. The deep-sea shrimp trawlers used to target two different types of resources. The resources include either red rings or other deep-sea shrimps mostly pandalid shrimps. Fishing operation of targeting for red ring are normally steered in high depth range (> 350 m) and for other deep-sea shrimps it ranges between 190-350 m. The average capital investment on shrimp trawlers was found to be 42.85 lakhs. The percentage contribution of average capital investments of deep-sea shrimp trawlers operated on Kerala coast is depicted in Figure 1. The highest capital investment is for the hull which constitutes 63.76 percent which is the major part of the investment followed by the investment for engine (23.57 percent). The average fixed cost was calculated from capital investment, insurance and interest on working capital. The average fixed cost per trip was estimated Rs. 15007 and Rs. 12701 for targeting for red rings and other deep-sea shrimps respectively.

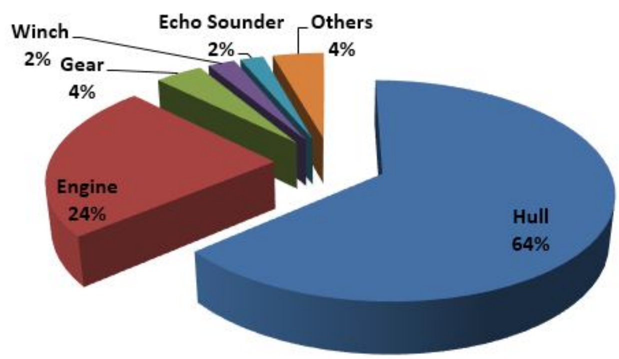

Fig 1: Percentage contribution of average capital investments of deep-sea shrimp trawlers operated on Kerala coast

The total operational cost entail the cost of fuel which was the chief constituent which contributed to around 55 percent followed by the crew share (22 percent), provision for ice (7 percent) and auction charges (6 percent).The average operational cost of deep-sea shrimps trawlers is represented in the Table 1. It was found that the operational cost of deep-sea trawlers was very high on an account of huge distance of fishing ground from the coast and lengthy fishing days. The frequent hike of the price of the diesel rate badly affects this sector. Comparing with hike of the diesel rate the price increment of deep-sea shrimp price is negligible. The rate of red ring was found to be Rs. 80-100 /kg ten years back [11] and presently the rate is Rs. 110-140/ kg. But in the case of diesel price the rate increased more than double.

Table 1: The average operational cost (per trip) of deep-sea shrimp trawlers

Particulars	Red ring Rs	Other deep-sea shrimps Rs
Fuel	118017 (55.83)	78952 (53.44)
Oil	1980 (0.94)	1010 (0.68)
Ice	14170 (6.70)	10355 (7.01)
Auction	12070.5 (5.71)	8316 (5.63)
Provisions	7526 (3.56)	6132 (4.15)
Maintenance	3250(1.54)	2900 (1.96)
Bata	7200 (3.41)	5600 (3.79)
Crew Share	45468.4 (21.51)	32843(22.23)
Others	1690 (0.80)	1640 (1.11)
Total	211371.9	147748

*Figures in parenthesis indicate percentage to total

The major catch of targeting for red ring is *Aristeus alcoki* where as in the case other deep-sea shrimps the targeting species includes *Plesionika quasigrandis, Heterocarpus gibbosus, H. woodmasoni* and *Metapenaeopsis andamanensis.* It was found that the trawlers targeting for red ring often caught large quantity of deep-sea shark as by catch. The catch composition of deep-sea shrimps and by catch species are plotted in Figures 2& 3. The landing price of deep-sea shrimp fluctuated with species, size and quality. The red ring, *A. alockii* is most valued species among deep-sea shrimp landing in Kerala and *P. quasigrandis* is the most dominant species in the landings. The average revenue per trip has been observed to be Rs. 293852 and Rs. 200097 for targeting for red ring and other deep-sea shrimps.

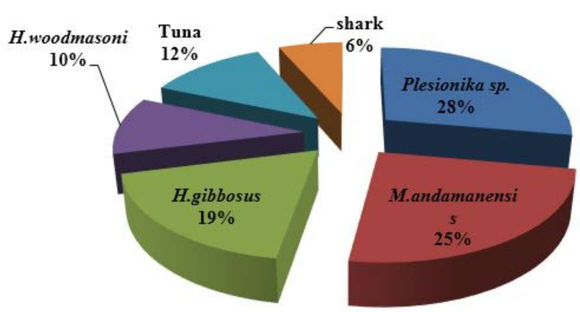

Fig. 2: Species composition in the trawlers targeted for other deep-sea shrimps

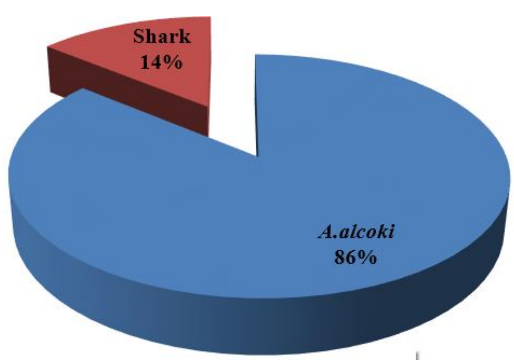

Fig 3: Species composition in the trawlers targeted for red ring

The economic evaluation indicated that net profit and net operating income was Rs. 79,156 and Rs.94, 163 respectively for trawlers targeted for red ring whereas the same was Rs. 43,169 and Rs. 55,870 for targeted for other deep-sea shrimps. The operating ratio worked out to be 0.69 and 0.72 for trawlers targeting for Red ring and other deep-sea shrimps respectively, indicating that 69 percent and 72 percent of the net revenue generated is used in its operating charge.The average operating ratio of deep –sea shrimp trawlers was 0.70, which is high when compared to coastal multiday trawlers (0.58) [18]. Rate of return, profitability ratio and the net profit ratio for the Red ring is estimated to be 0.35, 0.38 and 0.26 respectively. While for the other deep-sea shrimps it was found to be 0.28, 0.29 and 0.21.

3.2 Problems

In order to analyse the problems encountered in the deep-sea shrimp fishing operations, 90 trawl owners and labourers were interviewed using a pretested interview schedule. The important problems opined by them, were ranked and on the basis of the ranks assigned, Garette ranking technique was employed to analyse the problems related in the deep-sea fishing operations. The results of the Garette ranking technique are furnished in Table No. 2. The results point towards that the high operational cost, high risk and efforts, lack of trained and skilled persons, low market price realisation, abundance of discards, poor quality of shrimps, low level of technology were the major problems encountered in the deep-sea shrimp fishing operations .The highest score of 81.43, is for the high operation cost followed by the score of 80.95 for the low market price of deep-sea shrimps and the lowest score (17.14) for low level of technology.

Table 2: Analysis of the problems in deep-sea fishing operations - Garette Ranking Technique

Sl. No	Parameter	Score	Rank
1.	High cost of operation	81.43	I
2.	High risk & effort	70.95	III
3.	Lack of skilled persons	36.67	IV
4.	Low market price realisation	80.95	II
5.	Abundance of discards	30.95	VI
6.	Poor quality of shrimps	31.90	V
7.	Inadequate technology development	17.14	VII

The high cost of operation is one of the major problem faced by the deep-sea shrimp fishery sector was ranked first among the constraints faced by deep-sea shrimp trawlers. Trawl owners ranted that the deep-sea shrimp fishery is more expensive comparing with coastal fisheries and the high operational cost is the prime reason for the economic inefficiency of deep-sea shrimp operations. The major operational components in trawlers are fuel charges. The fuel share constitutes about 56 percent of total operation cost in deep-sea trawlers. But in the case of multiday trawlers operating less than 200 meter depth contribution of fuel cost is 49 percent [19]. Frequent hike of the price of the diesel had badly affected this sector. In contrast with the hike of fuel price there is no increment in the market price of deep-sea shrimps. The cost for ice, water, provisions and maintenance charge is also higher in trawlers operating in deep-sea. Discoloration in the deep-sea shrimps is rapid when comparing with coastal species. Storing the shrimps in the fish hold of the trawler with good amount of ice is the better method for avoiding the discolouration. So deep-sea trawlers need to keep more ice in the fish hold and it is also increase the operating cost of the trawler.

The market rate of deep-sea shrimp is comparatively low due to of low meat yield realisation. The overall average yield of meat in deep-sea shrimps is lower than that of coastal shrimps. The average yield of meat of deep-sea shrimp is 36 percent where as in coastal shrimp the yield is 64 percent [20]. In total deep-sea shrimp landings 95 percent are exported and local market preference is very meagre. One of the major quality problems in the deep-sea shrimp is its rapid discolouration (black) due to melanosis and it is observed that the melanosis is one the problem affecting the market value of deep-sea shrimp in international markets [21]. Black colouration is also caused due to inaccurate icing and long storage in the fish hold of the boat. In deep-sea shrimps especially in the case of pandalid (which contribute about 60 percent of total deep-sea shrimp landings in Kerala) have a little sweet taste and this also one of the reasons for less local market demand in Kerala while this has high demand in Japan. Due to sweet taste and sticky texture of pandalid shrimps the Japanese consume them raw [21].

The deep-sea fishing operations are very risky with the fishing ground is far-flung from the coast and the fishing voyage extended up to more than ten days. Climate condition of oceanic waters is not favourable for deep-sea shrimp trawling operation day in and out. The trawlers targeting for red ring undertakes operation at day and night time. The deep-sea shrimp fishery sector badly need more skilled and trained persons because of this reason. Most of the crew members in the deep-sea shrimp trawlers are from Thoothoor and nearby area of Kanyakumari district who had inherited their technical knowhow and experience form their forefathers. However the present generation isn't involved in the operations due to their interest towards better employment opportunities and moving out of fisheries. Thus there is an immediate need of trained persons in providing suitable training and scientific knowledge to fishermen for venturing into deep-sea shrimp fishery operations which will help to this sector.

The most of the deep-sea fishing grounds were in international shipping channel area and there was no appropriate vessel traffic management system (VTMS) along the Kerala waters off the Arabian Sea. Sometime heavy ship traffic happened along the fishing grounds and causes the accident during the fishing operation.

The deep-sea shrimp trawling operation often generate huge proportion of fish discards which ranges from 20-40 percent and sometimes exceed more than 80 percent [22]. Except for the sharks and few fins fishes (e.g. *Psenopsis* sp. and *Neopinnula* sp.) all the by –catch fishes are dumped to the sea. However in Tamilnadu since the fishing operation was done for single day it was profitable to get back from the sea either for fish meal production or human consumption .But in the case of deep-sea shrimp fishing operation in Kerala it is not profitable considering the huge cost of ice and storage for the by catch fin fishes. Pillai *et al.* [22] has identified 57 deep-sea fish species from deep-sea shrimp trawlers operating off Kollam. Unfamiliar appearance, taste and texture of deep-sea fishes caused the less market preference of this resources.

3.3 Prospects

The deep-sea fishery could provide additional source of fish landings to ensuring the fish food security in the state in the wake of numerous bottlenecks faced by coastal fisheries. Save of the policy units which includes over exploitation, juvenile fishing, discards, targeted fishery. As the deep-sea fishery resources could provide an alternative source of food and income for the masses, it is important to tap the underexploited deep-sea fishery resources. Sustainable and economically viable resources exploitation from deep-sea fishery sector is still possible through regulatory management strategies with concerted policy efforts specific for different species and for different regions. In order to promote the deep-sea shrimp fishery the government should provide adequate support and welfare measures to ensure that the cost of fishing operations tend to remain low variety thereby increasing the number of fishing operations. The cost of fishing operation indicated that the fuel share is high restrained to the number of operations. Government should provide subsidies for the fuel to reduce the higher operational cost. Technological lag and financial constraints had been the major bottlenecks in the delayed take off of the deep-sea fishing industry in India. The strengthening of the existing Indian fleet is a requisite to widen the exploitation of deep-sea fishery. Redesigning the fleet in order to reduce its size and, at the same time, improving the efficacy of the remaining vessels in order to increase their economic fitness will improve the deep-sea fishing constraints for the future.

Off late, the research institutes had discovered many new deep-sea fishing grounds based on the deep-sea exploratory survey and state of art technology. The fishermen are unaware about these fishing grounds. However, a holistic system should be developed with government initiatives at the centre to disseminate fishing leads to fishermen and the shifting from existing fishing grounds to new grounds also help to reduce fishing stress on same ground. Exploratory surveys for new fishing areas to be continued consequently map the potential fishing ground on a GIS platform and the data should be provided to the fishermen. The information of availability of such resources are to be regularly monitored and the information need to be passed on the fishermen and which would significantly increases the catch and revenue and thereby by ensuring optimal utilisation of fishery resources.

The occurrence of fishable concentrations of deep-sea resources together with stagnating coastal production necessitated the need to recognize the deep-sea fishing as a priority area for developing the industry. The study on the existing marketing system indicated that the marketing system is dismal without any forward or backward linkages.

The study indicated large quantities of by catch fin fishes available with deep-seas shrimp trawlers, which are dumped to the sea as it has very low market value. Presently the utilization of discards in India very less and is mainly used for production fish meal and fertilizer. The biochemical analysis indicated that many of the deep-sea fishes with high protein content and low fat [23, 24, 25]. The per capita protein availability is below the recommend level in India [26] and the accurate utilization of discard fishes is necessary. So there is exists a vast scope of expansion of value added products from deep-sea fishes for ensuring nutritional security. The development of accurate postharvest technology of deep-sea by catch finishes help to utilize these resources and it will support fishermen to earn more income. Recent studies shown that marine fishes are rich sources of bioactive peptides [27, 28, 29, 30, 31]. A variety of bioactive compounds have been extracted from the marine discard fishes with potential nutraceutical and medicinal values. In addition there exist scope to utilize the discards for the production of collagen, silage, gelatin, fish mince, hydrolysate, fish oil, surumi etc.

However there exits an increased risk and uncertainty in the deep-sea fishing operation necessitating free insurance coverage for deep-sea shrimp trawlers and vessel traffic management system implementing.So in future, proper studies should be carried out and these issues should be considered prior to the execution of the programs for encouragement of deep-sea fishery by government and government agencies. Further studies on the dynamics of this resources and associated fishery have to be encouraged for better management and sustainable use.

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