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Economic analysis of tuna pole and line fisheries in Lakshadweep

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Economic analysis of tuna fisheries of selected islands of Lakshadweep showed differential levels of profitability with maximum observed BC ration of 1.55 for Agatti followed by Kavaratti (1.38) and Minicoy Island (1.27 in 1/2 sharing system and 1.26 in 1/3 sharing system). On harvest side, major contribution to the fixed cost comes from interest on fixed capital ranging from minimum of 52.67% (Kavaratti) to maximum of 61.33% (Minicoy) owing to high initial investment. Among variable cost the percentage contribution of crew and non-crew manpower accounts to be 78%, 84.14% and 88.98% (89.08% in 1/3 share system) respectively in Kavaratti, Agatti and Minicoy emphasizes labour intensive nature of pole and line fishery in Lakshadweep.

[**Keywords:** Lakshadweep, Economic analysis, B-C ratio, Pole and line, Sharing systems]

Introduction

The fisheries sector contributed 0.83% to the Gross Domestic Product (GDP) and 4.75% to the agricultural component during 2014[1]. CMFRI has reported 601 species of fishes from the Lakshadweep waters. Fisheries of Lakshadweep can be broadly divided into Tuna Fishery, Non-Tuna Fishery (comprised of Sharks, Seer fishers, Rays, Perches, etc.) and Marine Ornamental Fishes. The fishing season in the Lakshadweep is from October to May. The common species of tuna in the Lakshadweep water are skipjack (*Katsuwonus pelamis*), Yellowfin (*Thunnus albacare*), Frigate (*Auxis thazard*) and Little tuna (*Euthynnus affinis*). Major fishing activity revolves around the Pole and Line fishing of the Skipjack Tuna (*Katsuwonus pelamis*)[2-3].

The real growth in the fish landings of the Union territory of Lakshadweeep was from the year 1980 with large scale introduction of mechanised or motorised boats fitted with bait tank[4].The total fish production had increased from 1760 tonnes in 1980 to the present level of 15612 tonnes[5]. During the same period, the number of specialized fishing crafts had also increased from 194 to 752[6]. Tuna landings in Lakshadweep are 13505 tonnes. They account 15.83% of Indian total tuna landings and 86.5% of the fish production of Lakshadweep islands[5].

The main fishing method practiced in Lakshadweep islands is pole and line except Androth[7]. Pole and line for tuna using live bait is the most important gear for tuna fishery with a contribution of 92.8% followed by troll line, drift gill net and handline, contributing 3.3%, 2.1% and 1.9%. In Androth, troll line is the major fishing method[1, 6]. As per the basic statistics (2012) there are about 2017 fishing boats in Lakshadweep. Non-mechanized forms about 52% of the fleets, followed by mechanized boats (28.11%) and motorized boats (19.8%).

Tunas are among the largest, most specialized and commercially important of all fishes[8]. They are the fourth major internationally traded fish commodity and contribute 8% to the international fish trade in value terms[9].The Indian Ocean contributes 19% of the world tuna catch[10-11]. Principal markets for tuna are Japan, USA and the European Union. Major commodities traded are sashimi, canned, chilled, frozen and smoked products. The export of tuna and tuna products has shown remarkable growth from 1230 tonnes in the year 2001-02 to an all-time high level of 37302 tonnes in the year 2007-08[12]. Three major species of tropical tuna caught in the Indian Ocean are

skipjack, yellow fin and big eye.

Tuna is one of the most economically underutilized fisheries in Indian waters, more than half of the potential tuna stock is located around the Lakshadweep waters. Potential tuna catch of the Indian EEZ is estimated at 2.78 lakh tonnes[13]. Total tuna landing in India is 85291 tonnes, which is 2.25% of total marine fish landings[14]. In India, 29.9% of Skipjack tuna catch is contributed by Lakshadweep fishery[15]. Indian tuna fishery is not well developed leading to a big gap between potential and actual catch. The constraints for such under-exploitation may be due to fishers depending only on inshore resources, continuation of outdated fishing practices, lack of proper incentives and training to the fishers.

Livelihood opportunity for the Lakshadweep islanders is limited. Natural resources form the basis for the traditional economy of the people. In the past, this was principally associated with coconut cultivation. However, this has now been replaced by the pole and line tuna fishing, which is considered as the mainstay of the island economy. It is estimated that about 13% of the total population of Union territory of Lakshadweep are active, full time fishermen and fisheries sector provide livelihood for about 60% of the people of Lakshadweep3. Such a huge contribution of tuna fisheries to the economics of Lakshadweep Island warrants an economic analysis to assess the viability of the sector and its future prospects.

The economics of the tuna fishing operations has not been seriously attempted in the past, as the oceanic tuna fishing is an emerging fishery. Purpose of the present study is to highlight Sharing system practiced and cost and returns involved in tuna fisheries of Lakshadweep.

Materials and Methods

Sampling setup for data collection:

Of all the group of Lakshadweep islands, as three islands vis., Minicoy, Androth, Agatti have been reported to have most of the tuna catch[16] and Kavaratti being the capital of Lakshadweep islands, from these three islands Minicoy, Agatti and Kavaratti (Fig 1) have been considered for the present study; Androth island was dropped because the major fishing method over there is not pole and line but troll line.

The period of primary data collection was from the first week of October to the third week of November 2014, spanning across 45 days. In each of these three islands, around ten days were fixed for data collection. To start with, the number of boat owners/ fishers was fixed as at least 30 in each island. In this manner 63, 39 and 46 fishers who were predominantly boat owners from the islands viz., Agatti, Minicoy and Kavaratti respectively were interviewed for the purpose of performing economic analysis.

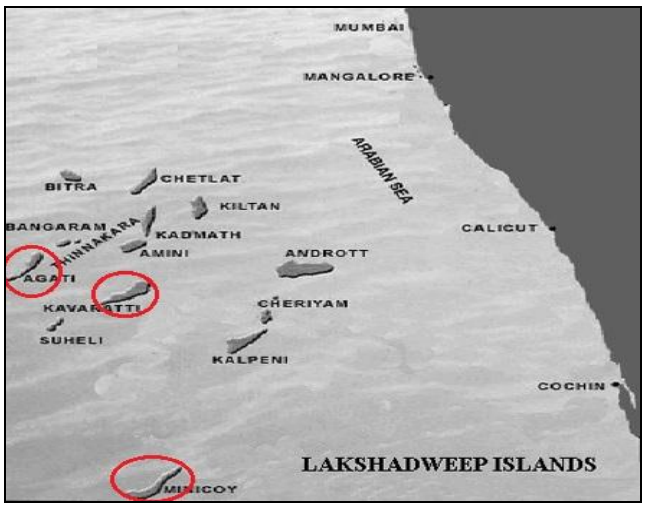

Fig 1 Selected islands of Lakshadweep considered in the present study

Initially, it was decided to follow the sampling design broadly on the line of the usual methodology for estimation of marine fish proposed by CMFRI, Kochi. However, as there is only one major landing center in each of these three islands, the first stage sampling unit is the respective landing centre itself. Moreover, by and large, the suggested random selection of calendar days using systematic sampling of two cluster days was followed in each island also taking into account the logistic problems associated typically with islands.

It is mentioned here that the total number of mechanized boats in Lakshadweep is 567 in 2010-11[17] of which majority employ pole and line fishing. Hence it can be stated that over 50% of the boat owners from each of the selected islands have been covered ensuring a sampling fraction of more than 0.5. On each day of data collection, the landing hours are usually between 4 to 8 pm. On any given day, around 15 to 20 boats land at the landing place. From this, around 3 to 5 boat owners/ fishers were covered at the landing/ marketing place. In this way, random selection of boat owners/ fishers has

been fairly ensured.

Initial investment: It comprises of cost of hull, engine, bait net, bait tank and others.

The others includes poles, hooks, *thoni*, GPS, compass, shower motor, shower, boat shed.

Fixed cost: For tuna pole and line fishing and *masmin* preparation

A cost that does not change with an increase or decrease in the level of production is called fixed cost. Fixed cost is the expenses that have to be paid by a farm, independent of any business activity. It is one of the two components of the total cost, along with variable cost. Fixed cost includes following aspects:

I. Depreciation on fixed assets: calculated using straight line method
II. Interest on fixed capital: calculated @ 12% per annum on fixed capital.
III. Expenses on repair and maintenance of fixed assets: estimated based on the information collected from sampled boat owners and fishers.

Variable cost (VC):

Variable cost is that part of the total cost which changes with change in output level. The daily expenses incurred are termed as operating cost or variable cost. It includes the following aspects: Variable cost for tuna fishing includes fuel, lubricant, food, carpenter cost (in Minicoy accounted in non-crew member share) and interest on working capital (calculated at 8.5% interest rate). Variable cost for tuna *masmin* preparation consists of coconut wood, coconut husk and salt. The share of crew and non-crew members are not included in variable cost and are accounted separately to highlight the prevalent sharing systems practiced in these islands.

Gross income: It was worked out by multiplying the quantity of fresh tuna and *masmin* with their respective prices.

Gross income = Q*P

Where,

Q= quantity of produce (kg)

P = Selling price (Rs./kg)

Benefit Cost Ratio (B:C Ratio) *or return over investment ratio*

B: C ratio or return over investment ratio was used to ascertain the viability of the business. It estimates the ratio of benefit and cost incurred in the business. Mathematically, it can be expressed as

$$\text{B:C Ratio} = (\text{Gross income}) / (\text{Total cost})$$

Estimation of number of fishing days:

The number of days calculated for pole and line fisheries of Agatti, Minicoy and Kavaratti was 200. The total number of fishing days was arrived at by subtracting number of holidays like Fridays, the month of Ramzan and other regional holidays based on consultation with fishers and officials from fisheries department. In addition to that, 20 days have been deducted from the remaining days for repairs and other works. The days have been worked out based on an inquiry from fishers. The distribution of these days along the different fishing months is uniform assuming the random nature of maintenance and repair requirements.

Estimation of total fish landing and price of fresh fish and masmin:

The selling price of fresh fish and average fish landing per trip for a month has been estimated based on interview with fishers, data enumerators of fisheries department and self-observation during the months of September, October and November. For the rest of the months, the figures are solely based on interviews. For both price and landings data, the average for the month is used for analysis. In cases where data in individual interview seem to be either very low or high than the majority of values, they are omitted from the calculation of average values. Accordingly, the price of fresh fish was arrived as Kavaratti, Agatti and Minicoy having prices in the range of Rs. 100-150, 100-200 and 120-150 respectively. The price of *masmin* is Rs.450/Kg in all the selected islands.

Revenue sharing system:

Revenue sharing system for pole and line fishery in Kavaratti and Agatti are same. In this system, 50% of total generated revenue (fresh fish and *masmin*) from a boat goes to the boat owner

whereas the remaining goes to the onboard fishers. However, the sharing is made separately in fresh fish and later on in *masmin.*

The sharing system of pole and line fisheries in Minicoy is quite different from what is practiced in Kavaratti and Agatti. Minicoy has two types of sharing systems. In the most prominent sharing system, 50% goes to onboard fishers and remaining 50% goes to the boat owner who has to pay to the non-crew members a share of 16% of the total generated revenue. In the other type of sharing system, 1/3rd of the generated revenue goes to the boat owner and the rest goes to the fishers who have to take care of the share of non-crew members.

Share seekers among non-crew members includes mechanic(2), carpenter(2), personnel attending to bait net(2)and live bait tank(2), the owner of the place where the boat is beached during off season(1), person who clean the area of the lagoon shore where the catch is unloaded(1), pole supplier(2), (*thoni*) small boat owners who brings the catch from lagoon to shore(1), hook suppliers(1), and for individuals involved in *masmin* preparation(2). The figures in the bracket represent the number of fishes.

Results

Initial investment in Tuna pole and line fishing unit:

The components of tuna pole and line fishing unit like hull and engines are capital intensive which makes tuna pole and line fishing, a high initial investment proposition. The initial investment across the different islands ranges from 13.89 to 14.54 lakhs (Table 1). Nevertheless, the difference in initial investment between different islands of Lakshadweep is meager.

Table 1 Initial Investment of tuna pole and line fisheries in Lakshadweep

Components of Pole and line fishing unit	Agatti (Rs. x 1000)	Kavaratti (Rs. x 1000)	Minicoy (Rs. x 1000)
Hull	956.75	1008.48	920.00
Engine	324.76	303.26	324.87
Bait net	26.27	24.35	24.21
Bait tank	24.79	19.61	20.56
Others	86.96	98.53	100.11

Economic evaluation of tuna pole and line fisheries in Agatti, Lakshadweep (Table 2):

Economic evaluation of pole and line fishery of Agatti Island showed the highest profitability among all the islands. Interest on the fixed capital is the major component of fixed costs accounting for 53.59% in fish harvest and 36.97% for processing followed by depreciation, which accounts for 31.88% and 63.02% respectively. Among variable costs, fuel outnumbered all other inputs with a contribution of 81.13% of the total variable cost for fishing. Coconut husk accounts for 56.7% whereas coconut wood contributed 36.08% towards the variable cost of tuna processing. Currently 10% of the total fish landed is sold as fresh fish generating average annual revenue of Rs.11.20 lakhs per boat which is substantially lower than the revenue generated from the sale of *masmin* (Rs. 78.37 lakhs). Half of the gross revenue i.e., Rs.44.78 goes to the boat owner and an equal amount goes to the fishers share which adds to the cost incurred by the boat owner making total cost of Rs. 57.62 lakhs.

The B-C ratio for the current pole and line fishery is calculated as 1.55 which is substantially higher than the other islands. Considering the possibility of infrastructural development, transport facility and market diversification in the coming years which would increase the proportion of fish sold as fresh commodity due to high price realization, an economic analysis is also carried out assuming 20%, 30%, 40% and 50% of fish landed, sold as fresh. The analysis shows the B-C ratio of 1.56, 1.57, 1.58 and 1.59 respectively. Above mentioned increasing trend in B-C ratio with an increase in the percentage of fresh fish sale shows promising future of this fishery.

During tuna processing, the husk and wood are important inputs but most of the people are not paying for these inputs as they are locally available, the actual realized B-C ratio is found to be 1.56, once these inputs are removed from the variable cost.

Economic evaluation of tuna pole and line fisheries in Kavaratti, Lakshadweep (Table 3):

Kavaratti is the capital of Union Territory of Lakshadweep and most populous island. High consumer demand and higher purchasing power of the consumer have led to higher price realization in

this island which has in turn made fishing a lucrative business. An insight into the economics involved in this fishery reveals that interest on fixed cost is the major component of fixed costs accounting for 52.67% in fish harvest and 36.04% for processing followed by depreciation which account for 27.43% and 63.95% respectively. Among variable costs, fuel contributes maximum (77.99%) to the total variable cost in fishing whereas coconut husk forms the major variable input (63.92%) in *masmin* preparation. Currently, 90% of the total fish landed goes for *masmin* production generating average revenue of Rs.48.45 lakhs per boat. Sale of fresh fish generates revenue of Rs. 8.89 lakhs making the total generated revenue from the entire catch as Rs.5733037.

The B-C ratio for the current pole and line fishery is calculated as 1.38 which is very good in economic terms explaining the success of pole and line fishery of this island. An increase in trend in B-C ratio is realized if the proportion of fish sold as fresh was increased from 10 to 50 percent with a step size of 10%. The calculated B-C ratio are 1.41, 1.43, 1.46 and 1.48 for 20%, 30%, 40% and 50% of fish sold as fresh respectively. Considering the fact that in most of the cases payments are not made for variable inputs like coconut wood and husk a more practical B-C ratio excluding these costs comes out as 1.39.

Economic analysis of tuna pole and line fisheries in Minicoy, Lakshadweep (Table 4 and 5):

Minicoy Island has the oldest history of pole and line tuna fishery in India. A tuna based canning industry is also located at Minicoy targeting the export market which consumes 2% of total tuna landed. Remaining 98% of the catch goes either to fresh fish market (10%) or to the traditional *masmin* industry (88%). An economic evaluation of the pole and line fisheries provided an insight into the cost involved in this sector. Among fixed costs, the major components are interest on fixed costs (61.33%) and depreciation (35.89%) for fish harvest and depreciation (71.56%) and interest on fixed cost (28.43%) for tuna processing. Fuel dominates the variable cost for fishing with a resounding contribution of 96.61% which is higher than the figure of 1997-98 (90.32%)[18]. Tuna processing involves major variable inputs like coconut husk (56.67%) and coconut wood (36.10%). Despite the presence of canning industry and its expected potential, only a small fraction of the catch is absorbed by this industry generating revenue of Rs.1.42 lakhs for each pole and line unit per year by the sale of fish at the rate of Rs.70 per kg. The bulk of the revenue comes from the sale of *masmin* which adds up to a figure of Rs. 80.51 lakhs and the remaining comes from the sale of fresh fish which amounts to Rs. 12.83 lakhs.

In Minicoy Island, there exist two systems of revenue sharing. In one of the systems, half of the Revenue generated goes as fisher share and from the remaining 50% share, boat owner claims 34% revenue and 16% goes to supporting people other than crew which are different from the figures of 33% and 12% given by Sivadas[18].

The increase in supporting people share observed during current work is attributed to the fact that the number of non-crew support staff with different skills have increased. In addition, each of these members has slightly hiked their share from 1.5 fish to 2. The analysis of B-C ratio gives a figure of 1.278, which is quite good. A higher B-C ratio of 1.286, 1.293, 1.300 and 1.31 is realized with assumed progressive increase in the proportion of fish sold (20%, 30%, 40% and 50%) as fresh. A B-C ratio is found to be 1.283 if no payment is made for the variables like wood and husk for tuna processing which is evident in most of the cases.

In another type of sharing system, boat owner gets one third of the share and the remaining two third of the share goes to the fishers who has to in turn pay for the rest of the non-crew supporting people. The B-C ratio calculated for the boat owner in this case is 1.267 which is slightly lower than the ½ share system. Despite lower B-C ratio this system is more prevalent. This could be due to the fact that in this system the boat owners need not have to worry about the shares of the non-crew supporting people which are taken care by fisher.

Discussion

An insight into the fixed cost for harvest and post-harvest activities related to pole and line fisheries in selected islands of Lakshadweep revealed more or less similar pattern among these islands. On harvest side, a major contribution to the fixed cost comes from interest on fixed capital ranging from a minimum of 52.67% (Kavaratti) to maximum of 61.33% (Minicoy). The remaining cost is contributed by depreciation.

Table 2 Economic analysis of tuna pole and line fisheries in Agatti, Lakshadweep

Fixed cost (fishing)	Rs. (x 1000)/Annum	%	VC (fishing-excluding crew share)	Rs. (x 1000)/Annum	%
Interest on fixed capital	170.34	53.59	Carpenter	9.48	1.12
Depreciation	101.32	31.88	Fuel	684.90	81.13
Maintenance	46.14	14.51	Lubricant	24.03	2.84
Total fixed cost (Fishing) [A]	317.81	100.00	Food	125.71	14.89
Fixed cost (processing)			Working capital	844.13	100.00
Depreciation	12.27	63.02	Interest on working capital	71.75	
Interest on fixed capital	7.19	36.97	Total variable cost (fishing) [C]	915.88	
Total fixed cost (processing) [B]	19.46	100.00	Total cost of fishing	1233.69	

	Proportion sold as fresh fish					
	Current Practice		Projected scenarios			
(Rs. x 1000)	10%	10% (without husk)	20%	30%	40%	50%
Variable cost (Processing)						
Salt	2.00	2.00	1.78	1.56	1.33	1.11
Coconut Wood	10.00	0.00	8.89	7.78	6.67	5.56
Coconut husk	15.71	0.00	13.97	12222.21	10.48	8.73
Total working capital	27.71	2.00	24.63	21555.55	18.48	15.39
Interest on working capital	2.36	0.17	2.09	1832.22	1.57	1.30
Total variable cost (Processing) [D]	30.07	2.17	26.73	23387.77	20.05	16.71
Total cost of processing	49.53	21.63	46.19	42852.55	39.51	36.17
Revenue from *masmin*	7837.48	7837.48	6966.65	6095.82	5224.99	4354.15
Revenue from fresh fish	1120.02	1120.02	2240.05	3360.07	4480.10	5600.12
Total revenue [F]	8957.50	8957.50	9206.69	9455.89	9705.08	9954.27
Boat owner Share	4478.75	4478.75	4603.35	4727.95	4852.54	4977.14
Fishers share [E]	4478.75	4478.75	4603.35	4727.95	4852.54	4977.14
Total cost incurred [G=(A+B+C+D+E)]	5761.97	5734.07	5883227.67	6004.48	6125.74	6246.99
B-C ratio [F/G]	1.55	1.562	1.564	1.57	1.58	1.59

Table 3 Economic analysis of tuna pole and line fisheries in Kavaratti, Lakshadweep

Fixed cost (fishing)	Rs. (x 1000)/Annum	%	VC (fishing-excluding crew share)	Rs. (x 1000)/Annum	%
Interest on fixed capital	174.51	52.67	Carpenter	20.57	2.54
Depreciation	90.88	27.43	Fuel	629.97	77.99
Maintenance	65.90	19.89	Lubricant	22.10	2.73
Total fixed cost (Fishing) [A]	331.28	100.00	Food	135.11	16.72
Fixed cost (processing)			Working capital	807.76	100.00
Depreciation	12.87	63.95	Interest on working capital	68.66	
Interest on fixed capital	7.25	36.04	Total variable cost (fishing) [C]	876.42	
Total fixed cost (processing) [B]	20.12	100.00	Total cost of fishing	1207.71	

	Proportion sold as fresh fish					
	Current Practice		Projected scenarios			
(Rs. X 1000)	10%	10% (without husk)	20%	30%	40%	50%
Variable cost (Processing)						
Salt	2.00	2.00	1.77	1.55	1.33	1111.11
Coconut Wood	9.28	0	8.25	7.22	6.19	5158.73
Coconut husk	20.00	0	17.77	15.55	13.33	11111.11
Total working capital	31.28	2.00	27.81	24.33	20.85	17380.95
Interest on working capital	2.66	0.17	2.36	2.07	1.77	1477.38
Total variable cost (Processing) [D]	33.95	2.17	30.17	26.40	22.63	18.86
Total cost of processing	54.07	22.29	48.06	42.05	36.05	30.04
Revenue from *masmin*	4843.64	4843.64	4305.45	3767.27	3229.09	2690.91
Revenue from fresh fish	889.39	889.39	1778.79	2668.19	3557.60	4447.00
Total revenue [F]	5733.04	5733.04	6084.25	6435.47	6786.69	7137.91
Boat owner Share	2866.52	2866.52	3042.13	3217.74	3393.34	3568.95
Fishers share [E]	2866.52	2866.52	3042.18	3217.74	3393.34	3568.95
Total cost incurred [G=(A+B+C+D+E)]	4128.29	4096.52	4300.13	4471.97	4643.80	4815.64
B-C ratio [F/G]	1.38	1.39	1.41	1.43	1.46	1.48

Table 4 Economic analysis of tuna pole and line fisheries in Minicoy having one by two sharing system, Lakshadweep

	Rs. (x 1000)/Annum	%	Variable Cost (fishing-excluding crew and non crew supporting share)	Rs. (x 1000)/Annum	%
Fixed cost (fishing)					
Interest on fixed capital	163.18	61.33	Carpenter	NA	
Depreciation	95.49	35.89	Fuel	747.43	96.61
Maintenance	7.38	2.77	Lubricant	26.23	3.38
Total fixed cost (Fishing) [A]	266.05	100.00	Food	NA	
Fixed cost (processing)	0		Working capital	773.66	100.00
Depreciation	18.01	71.56	Interest on working capital	65.76	
Interest on fixed capital	7.15	28.43	Total variable cost (fishing) [C]	839.42	
Total fixed cost (processing) [B]	25.16	100.00	Total cost of fishing	1105.47	

	Proportion sold as fresh fish					
	Current Practice		Projected scenarios			
	10%	10% (without husk)	20%	30%	40%	50%
	(Rs. x 1000)					
Variable cost (Processing)						
Salt	2.00	2.00	1.77	1.55	1.32	1.09
Coconut Wood	10.00	0.00	8.86	7.73	6.59	5.45
Coconut husk	15.70	0.00	13.92	12.13	10.35	8.56
Total working capital	27.70	2.00	24.55	21.40	18.26	15.11
Interest on working capital	2.35	0.17	2.09	1.82	1.55	1.28
Total variable cost (Processing) [D]	30.05	2.17	26.64	23.22	19.81	16.39
Revenue from *masmin*	8051.16	8051.16	7136.25	6221.35	5306.44	4391.54
Revenue from fresh fish	1282.52	1282.52	2565.05	3847.57	5130.10	6412.62
Revenue from canning	142.32	142.32	142.32	142.32	142.32	142.32
Total revenue [G]	9476.00	9476.00	9843.62	10211.24	10578.86	10946.48
Boat owner Share	3221.84	3221.84	3346.83	3471.82	3596.81	3721.80
Fishers share [E]	4738.00	4738.00	4921.81	5105.62	5289.43	5473.24
Non-crew support member share [F]	1516.16	1516.16	1574.98	1633.80	1692.62	1751.44
Total cost incurred [H=(A+B+C+D+E+F)]	7414.84	7386.96	7654.06	7893.27	8132.48	8371.70
B-C ratio [G/H]	1.278	1.283	1.2861	1.2937	1.30	1.31

Table 5 Economic analysis of tuna pole and line fisheries in Minicoy having one-third sharing system, Lakshadweep

	Rs. (x 1000)/Annum	%	Variable Cost (fishing-excluding crew and non crew supporting share)	Rs. (x 1000)/Annum	%
Interest on fixed capital	163.18	61.33	Carpenter	NA	
Depreciation	95.49	35.89	Fuel	747.43	96.61
Maintenance	7.38	2.77	Lubricant	26.23	3.38
Total fixed cost (Fishing)	266.05	100.00	Food	NA	
Fixed cost (processing) [A]			Working capital	773.65	100.00
Depreciation	18.01	71.56	Interest on working capital	65.76	
Interest on fixed capital	7.15	28.43	Total variable cost (fishing) [C]	839.42	
Total fixed cost (processing) [B]	25.16	100.00	Total cost of fishing	1105.47	
			Proportion sold as fresh fish		
	Current Practice		Projected scenarios		
	10%	10% (without husk)	20%	30%	40%	50%
			(Rs. x 1000)		
Variable cost (Processing)						
Salt	2.00	2.00	1.77	1.55	1.32	1.09
Coconut Wood	10.00	0.00	8.86	7.73	6.59	5.45
Coconut husk	15.70	0.00	13.92	12.13	10.35	8.56
Total working capital	27.70	2.00	24.55	21.40	18.26	15.11
Interest on working capital	2.35	0.17	2.09	1.82	1.55	1.28
Total variable cost (Processing) [D]	30.05	2.17	26.64	23.22	19.81	16.39
Revenue from *masmin*	8051.16	8051.16	7136.25	6221.35	5306.44	4391.54
Revenue from fresh fish	1282.52	1282.52	2565.05	3847.57	5130.10	6412.62
Revenue from canning	142.32	142.32	142.32	142.32	142.32	142.32
Total revenue [G]	9476.00	9476.00	9843.62	10211.24	10578.86	10946.48
Boat owner Share	3158.67	3158.67	3281.21	3403.75	3526.29	3648.83
Fishers share [E]	4801.17	4801.17	4987.43	5173.69	5359.95	5546.22
Non-crew support member share [F]	1516.16	1516.16	1574.98	1633.80	1692.62	1751.44
Total cost incurred [H=(A+B+C+D+E+F)]	7478.02	7450.13	7719.68	7961.34	8203.01	8444.67
B-C ratio [G/H]	1.267	1.272	1.275	1.283	1.29	1.30

The high contribution of interest on fixed capital is evidently due to high initial investment which is a characteristic feature of fish harvest sector. A pole and line unit (hull+engine+gear) roughly costs about Rs. 10-15 lakhs making it a capital-intensive profession. Maintenance cost of fishing accounts to 2.77%, 14.51% and 19.89% of total fixed cost for Minicoy, Agatti and Kavaratti islands respectively. It is noted here that maintenance cost is substantially lower in case of Minicoy due to the fact that, only maintenance of mechanical sprayer is included in the fixed cost and rest is accounted as non-crew share, which is 16% of the total generated revenue. In rest of the islands, the payment for maintenance and repair (carpenter) is made in cash. Contrary to the fixed cost involved in fish harvest, a major share in fixed cost for post-harvest sector comes from depreciation (63.02% to 71.56%) indicating lower life span of the concrete kiln (Average 10 years) and smoked fish drying units (2 years). Among variable cost for fishing, fuel forms a major input accounting for 77.99%, 81.13% and 96.61% for Kavaratti, Agatti and Minicoy respectively when the crew and non-crew supporting members were not included in the variable cost. When the same has been incorporated, the figure drops down to 17.14% and 12.86% for Kavaratti and Agatti. In Minicoy, it is 10.63% for one by two sharing system and 10.54% for one by three sharing system. Such a drop in percentage contribution of fuel towards variable cost signifies the labour intensive nature of pole and line fishery in Lakshadweep. A single pole and line unit needs a crew of nine persons which is substantially higher than trawl units. The crew share and non-crew share if included, variable cost comes out to be 78%, 84% and 88.98% (89.08% for 1/3 sharing system) in Kavaratti, Agatti and Minicoy respectively which is substantially higher than multiday trawler (25%) and multiday gillnetter (35%)[19, 20].

Economic analysis of pole and line fisheries of selected islands of Lakshadweep Island has shown differential levels of profitability in different islands. The reasons for the difference in B-C ratio are the differences in the quantum of average landings per boat, price realization in market and sharing system of revenue across the islands. Maximum profitability in pole and line fishery was observed in Agatti (1.55), followed by Kavaratti (1.38) and Minicoy Island (1.27 in one by two sharing system and 1.26 in one by third sharing system). If the annual catch per boat were analysed, it is maximum for Agatti followed by Minicoy and Kavaratti, which makes fishing in Agatti most profitable. The average annual catch is substantially higher in Minicoy when compared to Kavaratti yet its B-C ratio is lower than Kavaratti which could be attributed to the lower price realization in Minicoy for fresh fish and catch going for canning industry that is around Rs. 70/kg only. In addition to that, the sharing system of Minicoy Island is different than other islands where a handsome share of 16% goes to the non-crew members engaged in fisheries, which substantially lowers the B-C ratio for the boat owner. An earlier economic analysis of pole and line fisheries of Lakshadweep in 2006 shows a B-C ratio of 1.1021 which is considerably lower than the present estimate. This is due to the fact that over the years the boat size has undergone a drastic increase along with increase in number of fishing days which has resulted in substantially higher annual average landings. Along with the rise in landings, the price of fish has also increased owing to increase in population driven consumer demand. A substantially lower value of 1.10 in earlier estimates could also be due to the price (Rs. 22/kg) used for analysis of gross revenue that is probably an underestimate.

Conclusion

Economic analysis of tuna fisheries of selected islands of Lakshadweep showed differential levels of profitability when computed in terms of B-C Ratio. Maximum profitability in pole and line fishery was observed in Agatti followed by Kavaratti and Minicoy Island. On harvest side, a major contribution to the fixed cost comes from interest on fixed capital evidently due to high initial investment. Contrary to the fixed cost involved in fish harvest, a major share in fixed cost for post-harvest sector comes from depreciation. Among variable cost for fishing, fuel forms a major input accounting for 77.99%, 81.13% and 96.61% for Kavaratti, Agatti and Minicoy respectively when the crew and non-crew supporting members were not included in the variable cost. When the same has been incorporated, the figure drops down to 17.14% and 12.86% for Kavaratti and Agatti. In Minicoy, it is 10.63% for one by two sharing system and 10.54% for one by three sharing system. Such a drop in percentage contribution of fuel towards variable cost signifies the labour intensive nature of pole and line fishery in Lakshadweep. Hence, it can be stated that there is greater scope for tuna fisheries in Lakshadweep owing to its profitability.

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