CMFRI
bulletin 44
Part One

JUNE 1989

NATIONAL SYMPOSIUM ON RESEARCH AND DEVELOPMENT IN MARINE FISHERIES

MANDAPAM CAMP
16-18 September 1987

Papers Presented
Sessions I & II

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
(Indian Council of Agricultural Research)
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Central Marine Fisheries Research Institute
40
YEARS
1947-1987

NATIONAL STRATEGY FOR EXPLOITATION AND UTILIZATION OF THE POTENTIAL MARINE FISHERY RESOURCES OF INDIA - A PROJECTION

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It is more than a decade since the country declared in 1977 its maritime Exclusive Economic Zone covering an area of 2.02 million sq. km, thus inheriting a great wealth of living and non-living marine resources. The potential of marine fishery resources of the EEZ is of considerable magnitude and roughly estimated at 4.5 million tonnes based on different approaches by scientists. As against this, during the last one and a half decades there has not been any substantial increase in the marine fish production of the country which currently stands at about 1.6 million tonnes. The fact that a large gap exists between the potential resources and the actual yield is a matter of great concern.

Despite, increasing demand for fish and prawns in the internal and export markets, the industry has remained dormant and has not come forward to make large investments in new areas of fisheries and thus diversify their efforts. This is attributed to the lack of critical information on the presently exploited stocks as well as the potential resources which are remaining unexploited. The exploited resources, some of which having a high unit value, require rational exploitation and judicious management, whereas the precsently untapped offshore and oceanic resources need be exploited to the optimum level. Besides the need for precise information on the potential resources, much work remains to be done on the harvest and post-harvest technologies. Information on existing infrastructure and those needed for future requirements, economics of operation of various types of mechanised vessels, marketing facilities etc. is much wanting.

The time is ripe now for evolving a national strategy for exploitation and utilization of the resources of the EEZ, so that proper direction and support could be given to fisheries development programmes involving production and utilization.

The aim of the present document is to provide the background information on exploited marine fishery resources, group-wise potential resources, existing infrastructure, and give projections for additional exploitation of resources in the shelf and slope areas and utilization.

EXPLOITED MARINE FISHERY RESOURCES

The estimated annual fish landings (averaged over the 3 years 1983 to 1985) work out to 1.56 million tonnes. Almost 98 per cent of these landings is accounted for by the coastal fisheries limited to a depth of 50 m. The crafts operated are the small mechanised vessels (trawlers, purse-seiners, gillnetters, dolnetters and boats fitted with out board motor where mechanisation is used for propulsion and fishing or propulsion alone) and the artisanal units. Information on catches of larger vessels operated by the private industry is practically not forthcoming even-though concerted efforts were made by the Institute in the past to secure them. However, assuming even a liberal figure, it will be contributing only less than two per cent of the total landings.

Table I gives the avarage annual region-wise and species-wise composition of the fish landings during the years 1983-'85. About 11.0% of the landings is accounted for by oil-sardine followed by penaeid prawn

TABLE - 1

Regionwise and specieswise annual fish landings in India in tonnes (average of 1983 to 1985)

Species Region	Northwest	Southwest	Lowereast	Uppereast	Total
Elasmobranchs	23769	10658	13889	11600	59916
Eels	6608	31	227	840	7706
Cat fishes	22194	16382	3681	12081	54338
Chirocentrus	9295	1756	2539	3234	16824
Oil sardine	1079	160439	2615	300	164433
Lesser sardine	645	11395	30675	25717	68432
Hilsa ilisha	1029	135	652	4525	6341
Other *Hilsa*	6270	21	4805	4819	15915
Anchoviella (Stolephorus)	1878	53969	11263	5828	72938
Other clupeids	33535	15136	14398	18516	81585
Harpodon nehereus	106297	8	4	3795	110104
Saurida saurus	3571	7181	2190	1501	14443
Hemiramphus & Belone	300	701	1048	154	2203
Flying fish	1	24	1708	70	1803
Perches	13660	26998	13976	11368	66002
Red mullets	1410	143	2207	1506	5266
Polynemids	4775	1268	438	1860	8341
Sciaenids	52434	16558	11783	26236	107011
Ribbon fish	24507	8539	8480	12171	53697
Carangids	8740	22378	14288	8790	54196
Silverbellies	948	11151	47828	7239	67166
Lactarius	14111	3712	602	755	19180
Pomfrets	29419	3925	988	11730	46062
Mackerel	792	29195	7211	7039	44237
Seer fish	10390	12226	4926	7886	35428
Tunnies	6260	12549	2053	1374	22236
Sphyraena	415	1134	1583	477	3609
Mugil	2817	388	453	426	4084
Bregmeceros	1172	6	—	—	1178
Soles	8268	20786	2386	1374	32814
P. prawns	55045	41975	13939	12414	123373
N. P. prawns	50315	348	658	7938	59259
Lobster	2251	85	471	23	2830
Other crustacens	14682	22976	9679	3262	50599
Cephalopods	12472	6046	4071	1269	23858
Misc.	17408	13036	22246	4439	57129
TOTAL	548762	633258	259960	222556	1564536

(7.9%), Bombay duck (7.0%). Sciaenids (6.8%). *Stolephorus* (4.7%), lesser sardines (4.4%), silverbellies (4.3%), perches (4.2%), non-penaeid prawn (3.8%), elasmobranchs (3.7%), cat fishes (3.5%), carangids (3.5%), ribbon fishes (3.4%), pomfrets (2.9%), mackerel (2.8%), seer fishes (2.3%), soles (2.1%), cephalopods (1.5%) and tunnies (1.4%).

As seen from Table 1, the northwest region (comprising Maharashtra and Gujarat coasts) contributed 35% to the total landings, southwest region (comprising Goa, Karnataka, Kerala and Lakshadweep) 34%, lower east region (comprising Tamil Nadu and Pondicherry) 17% and upper east region (comprising Andhra Pradesh Orissa, West Bngal and Andamans) 14%.

The dominant species caught in the north west region are Bombay duck (19.4% of region's total), penaeid prawns (10.0%), sciaenids (9.6%), and non-penaeid prawns (9.2%). In the southwest region 30.0% of the landings is oil sardine, 10.0% *Stolephorus*, 8.4% mackerel and 7.9% penaeid prawns. Silverbellies formed the major component in the lower east region landings (18.4%) followed by lesser sardines 11.8% and perches, penaeid prawns and elasmobranches (about 5.4% each). In the upper east region the important species landed are sciaenids (11.8%) lesser sardines (11.6%), penaeid prawns (5.6%), ribbon fishes (5.5%), cat fishes (5.4%), elasmobranchs (5.1%) and perches (5.0%).

POTENTIAL RESOURCES

As stated earlier the production of marine fish in the country during the last few years remained more or less the same with fluctuations in the catch of some of the major groups. In the past, estimates of potential yield have been made by several authors based on primary production, explorarory surveys and catch rate and effort. Thus Jones and Banerji (1973) estimated potential yield at 2.5 million t. The National Commission on Agriculture (Anon..1976) estimated a production of 3.5 million t after 25 years.

With the declaration of the EEZ a revised estimate of the potential yield has been made according to which the annual yield could be 4 million t (Silas *et al.*, 1976) and 4.47 million t (George *et al.*, 1977) While the estimated harvestable fish potential showed a figure of about three times of the present yield it is felt that further increase in marine fish catches could come mainly from deep water or distant water fishing of under-exploited fish resources in the EEZ. Based on the estimates by George *et al.* (1977), the total exploitable resources upto 200 m depth zone is 2.30 million t from the west coast, 0.09 million t from the Lakshadweep and 0.16 million t from the Andaman & Nicobar islands. Besides, 0.5 million t of oceanic resources from all regions beyond 200 m depth zone could also be exploited.

Pelagic resources

It is estimated that the potential pelagic stock is 1.77 million tonnes (Table 2) as against the yield of about 0.7 million t. Among the exploited pelagic resources the most important group expected to contribute to significant additional yield is that of whitebait, especially from the Gulf of Mannar during July-September and from the southwest coast during October-December. The total potential of this category from the EEZ is estimated to be 0.24 million t as against the current yield of 73,000 t. The magnitude of additional yield will be about 0.15 million t within 20-50 m depth. The efficient gears for tapping this resource would be the small purse seine and mid-water trawl.

Carangids comprising of horse mackerel, scads and trevallies are estimated to have a potential stock of 0.27 million t against the current yield of 54,000 t. Additional yield to the tune of 0.2 million t could be expected from these resources. Grounds for this group have been located along the southwest coast, off Gujarat and upper east coast at a depth between 50-125 m. Apart from mid-water trawling, these resources can also be harvested by purse seines and drift gill nets.

Ribbon fishes of the estimated potential of 0.27 million t would yield considerable additional quantities from 20-80 m depth from the southwest, lower east and northwest coast

TABLE - 2

Estimated potential yield ('000 t) of different groups

	N.W. Coast	S.W. Coast	L.E. Coast	U.E. Coast	AN Lab	Total PY
A. *Demersal*						
Elasmobranchs	45	45	35	40	20	185
Cat fishes	90	120	25	75	—	310
Perches	30	120	75	15	10	250
Polynemids	10	—	5	25	—	40
Sciaenids	70	20	20	100	—	210
Leiognathid	—	15	55	30	—	100
Pomfrets	30	—	15	40	—	85
	275	320	230	325	30	1180
B. *Pelagic*						
Oil sardine	5	180	—	10	—	195
Other sardine	5	40	70	15	10	140
Anchoviella	—	160	80	—	—	240
Other clupied	55	10	40	45	15	165
Ribbon fish	90	110	45	25	—	270
Carangids	70	110	25	60	—	265
Mackerel	5	80	15	—	5	105
Seer fish	5	10	15	10	5	45
Bombay duck	80	—	—	20	—	100
Tunas & related sp.	10	60	10	10	150	240
	325	760	300	195	185	1765
C. *Shell fish*						
Penaeid prawn	30	95	20	35	—	180
Non penaeid prawn	90	—	5	10	—	105
Other crustaceans	5	10	20	5	—	40
Cephalopods	20	35	20	100	5	180
Other fishes	135	200	85	70	30	520
Total (A+B+C)	880	1420	680	740	250	3970
+ Oceanic fishes	—	—	—	—	—	500
						4470

Boat seine and trawl net are the suitable gears for the species.

Oil sardine, the most important coastal pelagic species caught in the country is presumed to be optimally exploited, while marginally the Indian mackerel may support some additional catches. However in the present account it is not considered as a significant resource for any substantial additional production.

The small tunes show a potential of 0.1 million t in Andaman waters and 50,000 t in Lakshadweep beyond 100 m depth and about 90,000 t along the mainland coast beyond 50 m depth. Introduction of large purse seine and suitable drift gillnet would help in tapping this resource. At present there is only marginal exploitation of oceanic resources. The total oceanic tuna potential of the EEZ is estimated to be around 0.5 million t consisting mainly of yellowfin, bigeye and oceanic skipjack. Sailfish, marlin and oceanic pelagic sharks also form an extra component. Recent longline operations of FSI (Joseph and John, 1986) and CIFNET (Swaminath et al., 1986) have indicated the

richness of these resources along the deeper shelf areas of the west coast.

Demersal resources

The estimated potential of demersal finfish resources of the EEZ is around 1.1 million t as against the total current yield of 0.41 million t.

Cat fishes promise the maximum additional resource with potential of 0.31 million t against the present yield of 54,000 t. Productive fishing grounds have been located along the upper east coast, northwest coast and southwest coast between 20 and 100 m depth ranges.

Perches having a potential of 0.25 million t against the exploited level of 66,000 t are the other important demersal resources. The 'Kalava' resource of the southwest coast, the resident and migrant perches of Wadge Bank, the threadfin bream resource in the 75-225 m depth range occurring in concentration during February-May and July-September along the southwest and upper east coasts are the major perch resources to be harvested.

The sciaenids of which the current yield is 0.11 million t show a potential of 0.21 million t. Rich grounds exist in the northwest and east coasts at a depth of 50-200 m. Likewise elasmobranchs with a current yield of 60,000 t indicate a potential of 0.18 million t. Good grounds are located in the lower east coast (100-200 m depth) and north-west coast upto 100 m depth.

Deep sea non conventional resources including potential stocks of the bulls eye, indian drift fish, black ruff, rat tails, boar fishes and miscellaneous varieties of deep sea fishes from the continental slope (220-500 m depth) are indicated from the southwest and east coasts.

Crustacean resources

Very little scope exists for increasing production of penaeid prawns from the traditional shrimp grounds. However, the non-penaeid prawns with a current yield of 59,000 t show a potential of 0.11 million t. Similarly the deep water shrimp and lobster with only the nominal yield of 500 t at present, indicate a potential of 12,000 t.

The sustainable potential of deep water prawns along the southwest coast is estimated at 3.000t. For deep water lobster, the estimate is 8.000t off the southwest coast and over 1.000 t off the lower east coast. The maximum abundance of deep sea prawns was observed in 300-400m depth during February-June. For exploitation of deep sea prawns and lobsters in the shelf and slope regions on the southwest coast and Gulf of mannar, larger trawlers will have to be used.

Cephalopod resources

Cephalopods consisting of squids, cuttle fishes and octopii are caught at present mostly from the west coast. The cephalopod resources are now obtained from general trawl operations. The additional resources of about 50,000t are expected from the areas beyond 50 m depth zone if direct method like squid jigging is introduced Considerable potential of oceanic squids is also indicated.

Seasons of commercial availability

It is difficult to sharply demarcate any season of commercial availability of the different resources in the tropical waters. However, the general seasonal pattern of availability of the target species in different regions as seen from the published literature is indicatad here. For the sake of convenience, the year is divided into three seasons: namely premonsoon (February to May), monsoon (June to Septmber) and postmonsoon (October to January).

In the northwest region availability of catfishes, perches, ribbonfishes and cephalopods are found to be more in pre and postmonsoon seasons and croakers, coastal tunas and crustaceans in monsoon and postmonsoon seasons.

In the southwest coast, perches, ribbonfishes, carangids, crustaceans and cephalopods are the important resources in the monsoon and postmonsoon seasons, croakers and coastal tunas in pre and postmonsoon seasons, perches and elasmobranchs in pre-

monsoon and monsoon seasons and whitebaits in postmonsoon season.

In the lower east coast, the better seasons for fishing for croakers, coastal tunas, elasmboranchs, crustaceans and cephalopods have been found to be pre and post-monsoon, the monsoon season for white baits and ribbon fishes and the premonsoon season for catfishes.

The season of commercial availability in the upper east coast for catfishes, costal tunas, carangids and perches has been found to be pre and postmonsoon seasons, the monsoon and postmonsoon seasons for croakers, ribbonfishes, elasmobranchs, crustaceans and cephalopods and the postmonsoon for whitebaits. Regarding deep sea prawns better catch rates were observed during June to September along east coast and September to February along the west coast.

EXISTING INFRASTRUCTURE FOR EXPLOITATION OF OFFSHORE RESOURCES

Vessels and gear

It was estimated that at the end of 1985 the following number of fishing vessels were operating in the offshore/deep sea areas around the Indian sub-continent.

14-18 m OAL vessels (Medium) : 28

18-40 m OAL veesels (Large) : 154

Most of the medium vessels were used for exploratory fishing and were operated by the FSI. Of the 154 large vessels, 50 were on charter from foreign agencies and were operated near Andaman and Nicobar Islands. Except for a few vessels which belonged to FSI, CIFNET and IFP of the Govt. of India, all the vessels below 30 m OAL were commercial shrimp trawlers. Vessels above 30 m OAL were mainly used for mid-water trawling, purse-seining and long lining.

TABLE - 3

Details of Fishery Survey Vessels operated by FSI

Name of vessel	OAL	BHP	GRT	Type of fishing conducted
Matsy Shakthi	36.5	825	327.18	Trawling
Matsya Vishwa	36.5	825	327.18	Trawling
Matsya Sugandhi	31.5	650	248.45	Tuna long lining & squid jigging
Matsya Varshini	36.5	1160	268.33	Purse-seining & trawling
Matsya Vigyani	32.21	750	257.95	Trawling
Matsya Nireekshani	40.5	2030	329.36	,,
Matsya Jeevan	36.5	825	327.18	,,
Matsya Harini	32.5	750	257.95	Purse-seining
Matsya Shikari	39.5	1740	352.47	Trawling
Matsya Darshini	36.5	1740	352.47	Purse-seining & trawling
Meena Anveshak	17.5	200	57	Trawling
Meena Gaveshak	17.5	,,	,,	,,
Meena Netra	17.5	,,	,,	,,
Meena Sitara	17.5	200	57	,,
Meena Tharangini	17.5	200	57	,,
Meena Pradata	17.5	200	57	,,
Meena Ayojak	17.5	200	57	,,
Meena Prapi	17.5	200	57	,,
Meena Saudagar	17.5	200	57	,,

TABLE - 4

Details of large vessels of IFP

Name of the Vessel	OAL (m)	BHP	GRT	Type of fishing in which engaged
Samudra Devi	27.31	750	193.86	Bottom/Pelagic trawling & Purse seining
Velameen	23.85	480	117.21	Bottom/pelagic trawling
Tuna	23.80	480	115.62	-do-
Klaus sunnana	19.81	220	61.28	-do-
Norind - II	13.17	72.5	19.27	Bottom/pelagic trawling and purse seining

TABLE - 5

Details of vessels of CIFNET

Name of vessel	OAL (m)	BHP	GRT	Type of fishing
Prashikshani	34.0	750	211.29	Tuna long-lining, trawling
Skipper-I	33.51	750	268.39	Long lining, purse seining, traps
Skipper-II	28.30	600	174.82	Trawling
Skipper-III	28 30	600	174.82	Trawling
Blue Fin	28.35	600	181.88	,,
Red Snapper	28.35	600	181.88	,,
Master Fisherman	17.5	200	57.0	,,
Master Fisherman-I	17.5	200	57.0	,,
Master Fisherman-II	17.5	200	57.0	,,
Master Fisherman-III	12.27	93	22.0	Gill netting, trawling

However, the vessels on charter and the existing shrimp trawlers would not contribute much to the supply of fin fish to the domestic market in particular because the charted vessels land their catches at foreign ports and the existing shrimp trawlers do not bring fish other than shrimp to the shore partly due to the sales obligations and partly due to the scarcity of storing space onboard.

The details of vessels and types of fishing conducted by the Govt. of India vessels attached to FSI, IFP and CIFNET are given in Table 3, 4 and 5.

Landing and berthing facilities

The details regarding fishery harbours completed/under construction located in the various states are given in Table-6 (Anon., 1983). A total of 15 harbours located at Veraval, New Ferry wharf, Ratnagiri, Marma Goa, Karwar, Malpe, Cochin, Vizhinjam, Tuticorin, Madras, Kakinada, Visakhapatnam, paradeep, Dhamra and Roychowk already constructed/under construction have a designed capacity for berthing about 500 deep sea/ offshore fishing vessels. However facilities for unloading of catches, supply of fresh water, fuel, ice and repair facilities for craft and gear are inadequate at most of the above mentioned harbours.

EXISTING PATTERN OF UTILIZATION

Fresh fish

In India about 2/3 of the total marine fish catch is being consumed in fresh

TABLE - 6

Fisheries Harbours completed/under construction with their designed vessel capacity (Source : BOBP/INF/3)

Region	Name of Port	Designed Capacity: Deep sea vessels	Designed Capacity: Mechanised boats
	Gujarat		
	Veraval	20	300
	Mangrol	—	210
	Porbander	—	140
NW Coast	Jaffrabad	—	32
	Vansi Porsi	—	45
	Kosamba	—	425
	Maharashtra		
	New Ferry Warf	N. A.	N. A.
	Sassoon Dock	—	700
	Ratnagiri	40	400
	Karanja	—	30
	Karnataka		
	Malpe	20	300
	Honavar	—	120
	Karwar	20	200
	Mangalore	—	230
SW Coast	*Kerala*		
	Cochin	57	450
	Sakthikulangara	—	500
	Vizhinjam	85	210
	Valiapatnam	—	54
	Mapila Bay	—	166
	Kasargod	—	100
LE Coast	*Tamil Nadu*		
	Tuticorin	65	300
	Madras	50	500
	Mallipatnam	—	54
	Kodiekkarai	—	54
	Cudallore	—	54
UE Coast	*Andhra Pradesh*		
	Visakhapatnam	50	300
	Kakinada	15	200
	Bavanappadu	—	200
	Nizampatnam	—	100
	Orissa		
	Paradeep	N.A.	N.A.
	Dhamra	15	35
	Chandipur	—	28
	West Bengal		
	Roychauk	15	—
	Andaman & Nicobar islands		
	Phoenix Bay	—	47

NA: Information not available

condition (Nair and Govindan, 1986). However the per capita consumption of fish declines considerably as the distance increases from the landing centre. Among the states the per capita consumption of fresh marine fish is the highest in Goa (37.26kg). It is the lowest in W. Bangal and Gujarat where only 1.07 and 1 47 kg respectively are consumed (Girija and Ravinath, 1986).

Frozen fish

Freezing as a means of fish preservation was first introduced in the country in the 1950s. Currently a little more than 5% of the total marine fish catch is being used for freezing purposes. The method is now mainly employed for export commodities like prawns, lobsters, squids and cuttle fishes of which the prawns rank first. A quantity of 49,540 t of frozen prawns were exported in 1985 and this works out to 74.51% of the total frozen sea food exported. With regard to fishes, a quantity of 9,557 t were frozen and exported in 1985 which accounted for 14.3% of the total frozen marine products exported.

Canned fish

In the 1960s and early part of the next decade shrimp canning and export was very popular in India. The record export of 2,199 t of canned shrimp was registered in 1973. Thereafter the exports dwindled down to a mere 15 tonnes in 1985. Fishes like sardines, mackerel and tuna were canned mainly for internal use. The set back to the industry has been caused by the increase in the cost of imported containers and edible oil. Alternative means of canning have been tested and found economical but the industry is rather slow in adopting these methods.

Cured and dried fish

The second largest method of utilization of fish in India is by salt curing and drying and this accounts for about 20% of the total fish landings. The traditional export markets for cured fish like Sri Lanka and Burma have dwindled in recent times. Being the easiest and the cheapest method of fish preservation it is bound to remain for quite a long time. In 1985 a total of 9,022 t cured/dried fishes were exported.

Fish marketing

As far as fish is concerned its marketing is as important as fishing itself. Fish has to reach the end user in the minimum possible time especially when it is marketed in fresh condition. Fish either in fresh or processed form has to go through several hands before it reaches the consumer. Thus fish marketing has several components like handling, transport, processing and storage. Intermediaries which consist of auctioners, commission agents, wholesalers, retailers and vendors also play important roles in marketing.

In India, fish is marketed as fresh fish, frozen fish, dry edible fish and fish meal. Regarding the physical flow of fish it is seen that in majority of cases, about 50% of the fresh fish marketed is consumed in nearby areas of the landing centres, about 45% within a distance of 200 km and the rest in places beyond 200 km. However, this may vary from state to state.

While the percentage of marine fish consumption is 62 in Maharashtra the same is only 2 in West Bengal. While Karnataka and Gujarat stand at top regarding exporting the fish to other states, Maharashtra and Tamil Nadu are the largest importers.

When the fresh fish flow from the production centre is taken into consideration, Veraval and Porbandar in Gujarat, Bombay in Maharashtra, Manglore in Karnataka, Cannanore and Cochin in Kerala, Madras in Tamil Nadu, Kakinada and Visakhapatnam in Andha Pradesh, Paradeep and Chandipur in Orissa are the largest exporters to other centres within and outside the states.

As far as dry edible fish is concerned, Maharashtra, Gujarat Karnataka and Andhra Pradesh contribute mostly to the inter-state movement. The maximum consumers of dry edible fish are in the non-coastal areas especially in the north-eastern states. In the major dry fish selling states the important centres that send out this commodity are Veraval and Porbander in Gujarat, Bombay and Poona in Maharashtra. Mangalore in Karnataka and Kakinada, Machilipatnam and Nizamapattanam in Andhra Pradesh.

More than 97% of domestic fish marketing and 93% of dry edible fish marketing are considered to have been handled by private trade. The co-operatives have very small share. The fishermen's co-operative societies as in Maharashtra take the fish directly to the consumers thereby ensuring maximum profit to the fishermen Eventhough many of the maritime states have fisheries corporations of some form or other, they are not effectively involved in fish marketing.

PROJECTION FOR ADDITIONAL EXPLOITATION

Vessel requirement

On the basis of data on potential resources and assumptions on possible catches by introducing suitable vessels and fishing methods, projections for the different resources are made. The plan is to harvest about 15-60% of the selected additional resources in a phased manner over a period of five years. Thus for the first year of implementation the strategy suggested is to harvest 0.11 million t of fish including white baits, coastal tunas, carangids, ribbon fishes, catfishes, perches, croakers, elasmobranchs, crustaceans and cephalopods (Table 7). This figure excludes the likely catches of oceanic tunas and cephalopods.

Table 8 gives the proposed additional number of vessels for a one year period. It is seen that to harvest the indicated 0.11 million t of fish in one year total of 160 vessels consisting of 65 numbers of 13 6 m wooden purse-seine vessels, 55 numbers of 17.5 m steel trawlers (mid-water/bottom) and 40 numbers of 26 m steel trawlers are to be deployed. The capital investment for the purse-seines would be Rs. 65 million, medium steel trawlers Rs.182 million and larger steel trawlers Rs. 400 million thus totalling to Rs. 647 million.

Each type of vessel will operate for the different resources for 200 days in an year. The region-wise distribution of the different types of vessels is given in Table 8.

Trained manpower requirement

The requirement of trained manpower for the different categories of vessels has been

TABLE - 7

Expected additional catch (t) for a one year period

Region	N.W.	S.W.	L.E.	U.E.	Total
Resource					
White baits	—	8820	10500	1680	21000
Coastal tuna	2535	5080	830	555	9000
Elasmobranchs	1375	420	1410	345	3550
Catfish	2770	3855	800	1435	8860
Perches	2500	4675	2475	1830	11480
Croakers	3800	1130	1230	700	6860
Ribbonfish	3410	2010	1180	1330	7930
Carangids	1605	2030	1915	2250	7800
Crustaceans	320	640	160	480	1600
Cephalopods	2750	1250	710	210	4920
Trawl by-catches	9435	6630	5610	3825	25500
Total	30500	36540	26820	14640	108500

TABLE - 8

Proposed additional number of vessels for one year period

	Region	NW	SW	LE	UE	Total
	Type of vessel					
1.	Purse seiner (wooden) (13.5 m OAL)					
a)	White-baits-100 days at 3t/day	—	17	20	3	40
b)	Coastal tuna 100 days (1t/day)					
2.	Purse seiner (Wooden 13.6 m OAL)	7	14	2	2	25
	Coastal tunas 200 days (1 t/day)					
3.	Trawler (17.5 m OAL)					
a)	White baits-100 days by mid-water trawling (2t/day)	—	19	22	4	45
	mid-water trawling (2t/day)					
b)	Catfish, ribbonfish, carangids and others					
—	100 days by mid-water/bottom trawling (2t/day)					
4.	Trawler (17.5 m OAL) Catfish, ribbonfish,					
	carangids and others	10	—	—	—	10
—	Mid-water/bottom trawling — 200 days (2 t/day)					
5.	Trawler (26 m OAL) Fish/crustacean	15	10	9	6	40
—	200 days					
—	bottom trawling (5 t/day)					
	Total	32	60	53	15	160

Note: Trawl by catch at ½ t/day for 200 days by 17.5 m vessels and 2½ t/day for 200 days by 26m vessels.

TABLE - 9

Requirement of trained personnel per vessel and for total no. of vessels for a one year period (Totals in brackets)

Category of posts	No. of personnel required			
	13.6 m purse * seines (65 units)	17.5 Trawler (55 units)	26 m Trawler (40 units)	Total
Skipper	—	1 (55)	1 (40)	2 (95)
Chief engineer	—	—	1 (40)	1 (40)
Mate	—	—	1 (40)	1 (40)
Bosun	1 (65)	2 (110)	2 (80)	5 (255)
Engine Driver	1 (65)	1 (55)	1 (40)	3 (160)
Engiee room Asst.	—	1 (55)	1 (40)	2 (95)
Fishing hands	6 (390)	5 (275)	10 (400)	(21) (1065)
Cook	1 (65)	1 (55)	2 (80)	4 (200)
Total	9 (585)	11 (605)	19 (760)	39 (1950)

*In the present type of purse seining where there is very little or no mechanisation involved in pursing and heaving the net a larger compliment of about 25 deck crew is required.

consideted based on the existing practices and regulations. It is estimated that a total of 1950 trained personnel including 85 skippers and 40 chief engineers are required for a one year period. Details of all the catagories required are given in Table 9.

Economics of vessel operations

The economics of operations of the different types of vessels are worked out on the basis of prevailing cost of vessel, operational costs as well as productivity and market prices.

For the 13.6 m wooden purse-seiner operating for whitebaits for 100 days and tunas for another 100 days, a net return of Rs. 0.22 million per annum against a capital cost of Rs. 1.0 million for the vessel and gear is arrived at (Table 10). The assumptions are: a catch of 300 t of whitebaits at the rate of 3 t/day for 100 days to be sold at Rs. 2.50 kg and a catch of 100 t of small tunas at the rate of 1 t/day for 100 days sold at Rs. 5 kg The net profit is computed after deducting fixed and operational costs including crew share (before taxation). From the second type of operation of the 13.6 m vessel, exclusively conducting small tuna purse-seining for 200 days of the year, a net return of Rs. 0.14 million is arrived at the assumption being production of 200 t of fish in a year at the rate of 1 t/day for 200 days, sold at Rs. 5/kg (Table 11).

TABLE - 10

Projected economics of operation of a 13.6 m OAL (wooden) purse-seiner for whitebaits

1.	*Capital Investment* (Rs.)	
1.1	Investment on craft + dinghy	7,00,000
1.2	Investment on gear	3,00,000
1.3	Total	10,00,000
2.	*Fixed cost* (Rs.)	
2.1	Depreciation @ 8.5% on vessel	59,500
2.2	Depreciation @ 50% on gear	1,50,000
2.3	Interest on capital @ 15% p. a.	1,50,000
2.4	Total fixed cost	3,59,500
3	*Operational cost* (Rs.)	
3.1	Fuel oil lubricants	
3.1.1.	@ 20 l/hr, 10 hrs. of running per day of fishing (main engine and auxiliary) @ Rs. 4.50/l for 200 days	1,80,000
3.1.2.	Auxiliary engine (5%) of above	9,000
3.1.3.	Lubricants	6,000
3.2.1.	Repairs and maintenance of vessel + dinghy	20,000
3.2.2.	,, ,, ,, gear	10,000
3.3.	Crew share for purse seiner (12,50,000 minus 2,49,000 (variable cost x 33% =	3,30,330
3.4	Quantum set apart for obtaining the services of carrier boats @ 15% of revenue realised out of white-bait catches minus 50% of the total variable cost	(7,50,000 minus 1,24,500) x 15% = 93,825
3.5	Expenditure for shore facility	6,000
3.6	Unloading of fish catches at the jetty	6,000
3.7	Cost of ice etc.	6,000
3.8	Miscellaneous	6,000
3.9	Total operational cost	6,73,155
4.	*Total cost* (Rs.)	10,32,655
5.	*Revenue from fish catches* (Rs.)	
5.1	Whitebaits purse seining 100 days @ 3 t/day of fishing x Rs. 2500/t	7,50,000
5.2	Tuna purse seining for remaining 100 days @ 1 t/day of fishing x Rs. 5000/t	5,00,000
5.3	Total revenue	12,50,000
6.	*Net earning* (Rs.)	2,17,345

7. *Economic parameters*

Rate of returns %	*Pay back period (years)*	*Fixed cost-gross returns ratio %*	*Operational cost-gross return ratio %*	*Fuel cost gross return ratio (%)*	*Break even catch level/annum*
37	2.4	29	54	16	210 t of white-baits & 70 t of tuna

TABLE - 11

Projected economics of operation of a 13.6 m OAL (wooden purse-seiner for tuna)

1.	*Capital investment* (Rs.)	
1.1	Investment on craft + dinghy	7,00,000
1.2	Investment on gear	3,00,000
		10,00,000
2.	*Fixed cost* (Rs.)	
2.1.	Depreciation @ 8.5 % on vessel	59,500
2.2.	Depreciation @ 50% on gear	1,50,000
2.3.	Interest on capital @ 15% p. a.	1,50,000
		3,59,500
3.	*Operational cost* (Rs.)	
3.1.	Fuel oil and lubricants	
3.1.1.	@ 20 l/hr. 10 hrs. of running per day of fishing (main engine and auxiliary) — Rs. 4.50/1 for 200 days	1,80,000
3.1.2.	Auxiliary engine (5%) of above	9,000
3 2.3.	Lubricants	6,000
3.2.	Repairs and maintenance of vessel + dinghy	20,000
3.3.	,, ,, ,, gear	10,000
3.4.	Crew share : 10,00,000 minus 2,49,000 (variable cost) x 33% =	2,47,830
3.5	Expenditure for shore management	6,000
3.6.	Unloading of fish catches at the jetty	6,000
3 7	Cost of ice etc.	6,000
3 8	Miscellaneous	6,000
3.9	Total operational cost	4,96,830
4.	*Total cost* (Rs.)	8,56,330
5.	*Revenue from fish catches* (Rs.) Operating 200 days @ 1 t/day of fishing x Rs. 5000/t	10,00,000
6.	*Net earning* (Rs.)	1,43,670

7. *Econmic parameters*

Rate of returns %	*Pay back period (years)*	*Fixed cost gross returns ratio (%)*	*Operational cost-gross returns ratio (%)*	*Fuel cost gross return ratio (%)*	*Break even catch/ annum*
29	2.8	36	50	20	156 t of tuna

For the 17 5 m steel trawler the capital investment estimated is Rs. 3.3 million. These vessels engaged in mid water and bottom trawling for 200 days a year are expected to obtain a catch rate 2 t a day of target fish and ½ t by-catch. A flat rate of Rs 6/kg has been assumed for the main catch and Rs. 2/ kg for the by-catch. The net profit is estimated to be Rs. 0 91 million for each vessel (Table 12).

With regard to the operation of 26 m steel trawler, the capital cost for vessel and gear is taken to be Rs. 10.0 million (Table 13). The revenue computed for this vessel is on the basis of a catch at the rate of 5 t/day for 200 days comprising mixed quality fishes

TABLE - 12

Projected economics of operational of a 17.5 m OAL Steel trawler

1.	*Capital investment* (Rs.)	
1.1	Investment on craft	30,00,000
1.2	Investment on gear	3,00,000
1.3	Total	33,00,000
2.	*Fixed cost* (Rs.)	
2.1	Depreciation — 8.5% on vessel	2,55,000
2.2	Depreciation — 50% on gear	1,50,000
2.3	Interest on capital @ 15% p. a.	4,95,000
2.4	Total fixed cost	9,00,000
3.	*Operational cost* (Rs.)	
3.1	Fuel oil and lubricants	
3.1.1	@ 40 l/hr. 10 hrs of running per day of fishing (Main & Aux.) @ Rs. 4.50/l for 200 days	3,60,000
3.1.2	Auxiliary engine 5% of above	18,000
3.1.3	Lubricants	18,000
3.2	Repairs and maintenance of the vessel	1,00,000
3.3	Repairs and maintenance of gear	40,000
3.4	Salary of crew	2,00,000
3.5	Expenditure for shore management	10,000
3.6	Incentive to crew	25,000
3.7	Unloading at jetty, cost of ice etc.	12,000
3.8	Miscellaneous	6,000
3.9	Total operational cost	7,89,000
4.	Total cost (Rs)	16,89,000
5.	*Revenue from fish catch* (Rs) 400 t @ Rs. 6,000/t for main catch and 100 t @ Rs. 2,000/t for by-catch	26,00,000
6.	*Net earning* (Rs.)	9,11,000

7. *Economic parameters*

Rate of returns %	*Pay back period* (*years*)	*Fixed cost-gross return ratio* %	*Operational cost-gross return ratio* (%)	*Fuel cost-gross returns ratio* (%)	*Break even catch annual*
43	2.5	35	30	15	260 t of main catch & 65 t of by-catch

like carangids, perches, cat fishes, croakers and crustaceans and 2½ t/day of by-catch. The price indicated for the catch is a flat rate of Rs. 6/kg for the main catch and Rs. 2/kg for by-catch. The net profit arrived at is Rs. 2.1 million.

Some of the economic parameters relating to the operation of the four types of vessels have been estimated and the values are given in item 7 of the Tables 10 to 13. As seen from the tables, the rate of return, in all the four

TABLE 13

Projected economics of operation of a 26 m OAL steel trawler

	Capital investment (Rs.)	
1.1	Investment on craft	95,00,000
1.2	Investment on gear	5,00,000
1.3	Total	100,00·000
2.	*Fixed cost* (Rs.)	
2.1	Depreciation @ 8.5% on vessel	8,07,500
2.2	,, @ 50% on gear	2,50,000
2.3	Interest on capital @ 15%	15,00,000
2.4	Total fixed cost	25,57,500
3.	*Operational cost* (Rs.)	
3.1	Fuel oil and lubricants	
3.1.1	@ 75 l/hr 20 hrs. of running/day of fishing (Main & Aux.) @ Rs. 4.50/l for 200 days	13,50,000
3.1.2	4 hrs/day for Aux. for 200 days @ 10 l/hr @ Rs. 4.50	36,000
3.1.3	115 days on shore at jetty-Auxiliary engine 8 hrs/day @ 10 l/hr @ Rs. 4.50	41,400
3.1.4	Lubricants and refrigerants	1,00,000
3.2	Repairs and maintence of vessel	2,50,000
3·3	Repairs and maintenance of fish gear and fabrication of new gear	1,00,000
3.4	Salary of officers and crew	3,00,000
3.5	Expenditure for shore management	30,000
3.6	incentives and allowance to crew	70,000
3.7	Unloading of fish catches at jetty	35,000
3.8	Miscellaneous	35,000
3.9	Total operational cost	23,47,400
4.	*Total cost* (Rs.)	49,04,900
5.	*Revenue (Rs.) from fish catches* 1,000 t @ Rs. 6,000/t for main catch and 500 t @ Rs. 2,000/t for by-catch	70,00,000
6.	*Net earning* (Rs.)	20,95,000

7. *Economic parameters*

Rate of returns of %	*Pay back period* (years)	*Fixed cost-gross returns ratio* (%)	*Operational cost-gross returns ratio* (%)	*Fuel cost-gross returns* %	*Break even catch annum*
36	3.2	37	34	20	700 t of main catch & 350 t of by-catch

types is quite high to indicate economic viability in their operations under the stated conditions. The operational cost-gross returns ratio is much higher for purse-seiners. This is mainly because of the higher proportion of the revenue which goes as the total wage amount in purse-seiners as compared to trawlers

The project economics of operation for a 34 m steel tuna long-liner is shown in Table 14. Wide variation in the hooking rate as well as for unit price have been reported. Assuming a price of Rs. 10,000/t for tuna and Rs. 5,000/t for by-catches the break-even level of production has been worked out as 540 t of tuna per annum.

TABLE - 14

Projected economics of operation of a 34 m OAL tuna long-liner (steel)

1.	*Capital cost* (*Rs.*)	
1.1	Vessel	1,20,00,000
1.2	Long line gear (300 baskets with 5 hooks each)	3,00,000
1.3	Total	1,23,00,000
2.	*Fixed cost* (Rs.)	
2.1	Depreciation @ 8.5 on vessel	10,20,000
2.2	Depreciation @ 50% on gear	1,50,000
2.3	Interest on capital @ 15 %	18,45,000
2.4	Total fixed cost	30,15,000
3.	*Operational cost* (Rs.)	
3.1	Fuel oil and lubricants	16,16,000
3.2	Cost of bait fish 150kg/day x 15 day x 15 days/trip x 11 months x Rs. 4/kg.	99,000
3.3	Crew salary	3,10,000
3.4	Incentive to crew	3,03,527
3.5	Stores and incidentals (12,000 x 12)	1,44,000
3.6	Repairs (2000 x 12)	24,000
3.7	Berthing and other port charges (5,000 x 12)	60,000
3.8	Annual drydocking	5,00,000
3.9	Total operational cost	30,55,527
4.	*Total cost* (Rs.)	
*5.	*Break even catch level and returns*	
5.1	Value (Rs) of break even catch level of 540 t (539.60 t correct to 2 decimals) of tuna per annum (20 days) of actual fishing per month and 10 months operation) @ Rs. 10,000/t	53,96,024
5.2	Value (Rs.) of by catches (one fourth of by catches (one fourth of tuna catches) @ Rs. 5,000/t	6,74,503
5.3	*Total revenue* (Rs.)	60,70,527
6.	*Net returns* (Rs.)	Nil

* As the catch rates and unit prices cited in literature are highly varying, only the breakeven catch level at the price of Rs. 10,000 t is considered in the above tables. However, profits for various combinations of catch levels and unit prices have been calculated and the same are presented in Table.

Exploitation of oceanic resources

Tunas: Under this category the oceanic tuna resources are of prime importance. In this regard the suggestions given in this paper are purely indicative.

Silas and Pillai (1985) have made certain time bound projections on the possible development of commercial tuna production. They envisaged a target of achieving 23,000 t of large oceanic tunas by long lining by 1990. Recently the exploratory long lining conducted by the Central Institute of Fisheries Nautical Engineering and Training northwest of Mangalore within the EEZ has demonstrated the commercial availability of yellow fin tunas in these areas (Swaminath *et al.*, 1986). The results of tunas long lining by Fishery Survey of India vessel 'Matsysugandhi' also revealed very rich tuna grounds in the same area (Joseph and John, 1986).

However, private or public sector entrepreneurship have not so far seriously attempted commercial exploition of these resources and as such no progress has yet been made in exploiting oceanic tunas.

Long lining and purse-seining or oceanic tunas are being carried out successfully in the western Indian Ocean mainly by France, Spain, South Korea and Japan by obtaining licences for fishing in the EEZ of Seychelles, Somalia and Mozambic.

In this context, immediate option for India for the exploitation of large oceanic tunas in the EEZ is to organise operation by a small tuna long lining fleet. The feasibility of commercial purse seining also should be explored.

TABLE - 15

Expected profit ('000 Rs/annum) in tuna long-liner (34 m) operations for different levels of catch and unit prices

Catch level of tuna (t/annum)	Price of tuna ('000 Rs. per t)						
	10	15	20	25	30	35	40
150	-4164	-3451	-2739	-2026	-1314	-601	111
200	-3629	-2679	-1729	-779	171	1121	2071
250	-3095	-1908	-720	467	1655	2842	4030
300	-2561	-1136	289	1714	3139	4564	5989
350	-2026	-364	1299	2961	4624	6286	7949
400	-1492	408	2308	4208	6108	8008	9908
450	-958	1180	3317	5455	7592	9730	11867
500	-423	1952	4327	6702	9077	11452	13827
550	111	2724	5336	7949	10561	13174	15786
600	646	3496	6346	9193	12046	14896	17746
650	1180	4267	7355	10442	13530	16617	19705
700	1714	5039	8364	11689	15014	18339	21664
750	2249	5811	9374	12936	16499	20061	23624
800	2783	6583	10383	14183	17983	21783	25583
850	3317	7355	11392	15430	19467	23505	27542
900	3852	8127	12402	16677	20952	25227	29502
950	4386	8899	13411	17924	22436	26949	31461
1000	4921	9671	14421	19171	23921	28671	33421
Break even catch level (t annum)	540	374	286	231	194	167	147

However, in both cases joint venture/chartering arrangements and availing foreign expertise from countries like Japan will be required for successful commercial implementation of these programmes by India.

The main fishing unit proposed for exploitation of oceanic tunas is the 34 m steel tuna long liner. The vessel and gear are estimated to cost Rs. 12.3 million (Table 14). As the catch rates and unit prices cited for tuna long line fishing are highly varying, it is felt useful to provide a table of profit values for a wide range of catch level and unit price. The estimated profits for different combinations are given in Table 15. In the calculation, value of by-catches has also been included on the revenue side.

As seen from the table, if the price of a kg of tuna is Rs. 20/kg, at the landing centre, more than 286 tonnes of tuna should be caught per annum for profit, while if the price is Rs. 10/kg, more than 540 tonnes should be caught per annum for profit. Other combination can be read out from the table. The tabular information helps in arriving at the number of long-liners required for economically exploiting a specified quantity of the resource.

Cephalopods: George *et al.* (1977) indicated a potential yield of 0.18 million t of cephalopods from the Indian EEZ.

Silas (Ed. 1985) emphasises the urgent need for developing directed fishing for cephalopods from our continental shelf waters and suggests utilization of some of the mechanised boats (9-13 m) for light fishing with lift nets. It is also suggested that the traditional gears for specific capture of squids and cuttlefishes are upgraded and use of traps and posts for *Octopus* in the reef and lagoon areas eccouraged. The multi-species trawl fishery of the inshore shelf bring in cephalopods in various proportions and the utilisation of these catches is to be improved.

The Taiwanese bull trawlers which fished on charter arrangements along the northwest coast of India in the early eighties confirmed the existence of excellent squid and cuttlefish grounds in this area.

From 15,80 t in 1982, the cephalopod catches have registered a rise to 42.64 t in 1986 indicating the increased effort and returns in this fishery. This catch has overshot the 30,000 t of potential harvest projected by Silas (Ed , 1986) for the year 1990.

Chikuni·s (1984) estimate of potential yield of neritic cephalopods from the Bay of Bengal is of the order of 50-100 thousand t and from the Eastern Arabian Sea 100-150 thousand t. In this context it is essential that concrete steps are taken to harvest much more of this under exploited resource of our neritic and oceanic waters.

In addition to strengthening the efforts in harvesting cephalopods from the neritic waters pioneering efforts are to be made in target fishing for some of the known commercial oceanic species of cephalopods. Among them are to be mentioned the Indo-Pacific species *Symplectoteuthis oulaniensis* apparently restricted to the northern and central parts of the Indian Ocean.

'Shoyo Maru' surveys (Fishery Agency, 1976 to 1979) located significant stocks of *S. oulaniensis* in north Arabian sea. The species, however, is not at present known to be commercially exploited in any part of the Indian Ocean.

Jigging, light fishing and drift gill net fishing are the appropriate techniques for exploitation of cephalopod resources of EEZ for which expertise are to be drawn preferably from Japan through joint venture or charter arrangements.

Due to lack of precise information on items such as productivity, distribution and economics no specific projections are made regarding the number of squid-jiggers and other vessels required. A series of simulated commercial fishing would help in generating the required data base. A programme is already under way to test the technical feasibility and economic viability of squid jigging in the Indian waters under the auspices of CIFNET, FSI and CMFRI and the results are awaited.

PROJECTIONS FOR ADDITIONAL REQUIREMENT OF INFRASTRUCTURE FACILITIES

For the exploitation of the projected potential of resources from the existing grounds as well as from the rest of the EEZ apart from suitable crafts and gears, several infrastructure facilities like harbours, ice and freezing plants, curing and drying plants, fish meal plants, and adequate facilities for transportation are required and the following is a discussion on the same.

Landing and berthing facilities

An examination of the existing facilities for landing and berthing the mechanised boats and deep sea fishing vessels indicates that the capacity of the harbours and jetties currently available cannot meet any future demand. The designed berthing capacity of the major and minor ports completed / under construction (Table 6) is for about 500 deep sea vessels (Anon., 1983). If all the facilities at the ports are established as originally envisaged this would cater to the needs of existing as well as additional vessels proposed for the first year. However proportionate expansions of harbour facilities will be required to accommodate progressive introduction of boats during subsequent years. Therefore it is suggested that action may be taken to build up the full capacities and expand all the infrastructural facilities at selected centres.

Requirement of ice

Ice is being used irrespective of the fact whether the fish is consumed fresh in nearby places or at distant places or even exported. At present a total production capacity of 2,000 t of ice per day exists in the country, established in different regions; 480 t UE coast, 335 t LE coast, 885 t SW coast and 330 t NW coast (Anon., 1983). Several estimates of requirement of ice have been made which according to various uses may vary from 0.75 to 1.25 kg per kg of fish. Taking a figure of 1 kg of ice per kg of fish, the total requirement for projected additionally exploited resource of 0.11 million t would be 0.11 million t of ice a year. Thus at the end of the 5th year, production of 0.55 million t of ice pery ear would have to be effected to meet the rquirements of the additional production. The additional ice plants to meet the requirements are proposed to be established at 9 major centres, namely Veraval, Bombay, Malpe, Cochin, Tuticorin, Madras, Visakhapatnam, Paradeep and Roychowk. The number and capacity of the plants at each centre would depend on the landings for which guidelines can be drawn from the distribution of expected landing figures (Table 7).

Cold storage

Cold storages are used for storing ice, storing fresh fish and for storing frozen fish. As on April, 1985 there were 272 freezing plants and 308 cold storages with the total storage capacity of 34,300 t of fish and a daily freezing capacity of 1,900 t (Bhaduri, 1985). The region-wise availability of freezing plants and cold storages is given in Table 16. However, at present most of the cold storages are not functioning or are being used for storing ice due to lack of demand for fish storage. There are some large cold storages where 95% of the space is used for other than fishery purposes. In this context, immediate expansion of cold storage capacity is not envisaged.

TABLE - 16

Freezing plants and cold storages in India

Region	Freezing plants	Cold storages
U. E. Coast	73	62
L. E Coast	27	36
S. W Coast	114	148
N. W. Coast	58	62
Total	272	308

Source : Fishing Chimes Oct., 1986.

Curing and drying facilities

At present most of the curing and drying of fish are being done in open air conditions. This calls for the establishment of modern facilities for these purposes. Curing and drying being the second largest method of fish utilization in the country, elaborate infrastructure facilities are required to be

established and hence the same could be taken up as a phased programme in the years to come. At present about 20% of the total marine fish catch (about 0.3 million t) goes for curing and drying (Nair and Govindan, 1986). Assuming that the same ratio will hold for projected additional production of 0.11 million t fish a year, modern facilities for drying 0.022 million t of fish are to be immediately established at the major and minor fish landing centres, where these catches are expected to be landed. In view of the large quantities of *Stolephorus* spp. which are expected to be landed along the lower east coast, a major facility may be established at Tuticorin and near about centres. To start with plants of appropriate capacities as per CIFT specifications may be established at the major and minor fisheries harbours.

Fish meal plants and fish pulverizers

The capacity of fish meal plants in the country (Gupta *et al.*, 1984) has been estimated as 374 t per day and that of the fish pulverizers to be 925 t per day (in terms of fresh weight). The total production capacity of fish meal plants and pulverizers was about 0.474 million t, per annum as against the actual production of 0.24 million t, thus indicating idling of these plants by more than 50% of their capacity. Therefore it is presumed that the available capacity of these plants is sufficient to meet the first five years requirements of the additionally exploited resources also.

Diversified processing

For better utilization of the fish caught, it is but necessary to diversify the products and test their marketability. In this way several of the so called low quality fish can find better utilization. This is especially the case with respect to the large stocks of meso-pelagic resources which are yet to get accpted in the domestic markets. Tecnologies are now available for diversified processing of marine fish. One such method is picking meat from small and miscellaneous fishes and making it into frozen blocks known as 'Kheema' which could be used for preparing a variety of items such as fish extract, fish paste, fish flake, fish finger etc. Fish protein concentrate is prepared from such picked meat. Bacteriological peptone useful for preparing culture media for microbial organisms is also prepared from minced fish. The fish hydrolysate can be incroporated with malt, sugar, cocoa powder etc. and dried to yield a fine beverage. The same minced fish can be used for preparing fish soup powder. Fish pickling can also be tried. With the exploitation of the additional resources as projected in the paper, large quantities of coastal tuna would be landed. It is suggested that 'mas min' (smoked tuna fish) may be produced at selected centres of southwest and lower east coast for internal marketing.

Table 17 gives the list of some of the important diversified products developed and marketed by I. F. P. Largescale adoption of these techniques would go a long way in promoting conversion of the cheaper and non-conventional varieties of fish to value added products.

TABLE - 17

Some of the important diversified products developed and introduced into the market by the Integrated Fisheries Project, Cochin during the period 1968-84

1. Deep sea lobster tails
2. Fish fillets
3. Cuttle fish and squid fillets
4. Fish Keema
5. Fish roe
6. Dried fishes
7. Fish fritters
8. Fish soup
9. Fish powder
10. Pasterised deep sea shrimp
11. Dried squid wafer
12. IQF products
13. Mas - min from tuna
14. Canned fish products in oil and brine
15. Frozen fish, crustaceans and molluscs
16. Lobster pickles

Requirement of transport facilities

Proper transport facilities are essential for this easily perishable commodity. Mode of fish transportation varies according to

type of consuming centres. Fish is transported either in fresh condition or in processed from. Processed fish includes sundried and salt cured fish and fish meal. The fresh fish for local consumption is transported in cycles or as head loads, while to far off consuming centres it is done either by truck or rail. Transportation to processing plants is also involved. However, no information is available about the average distance for transportation of different types of fish in different regions.

As mentioned earlier about two-thirds of the fish produced is consumed in fresh condition out of which about 50% is assumed to be consumed in areas nearer the coastal belt. The balance of the annual additional production, namely, 36,000 t of fish would have to be transported to longer distances. Assuming rail transport for one-fourth of this quantity, about 27,000 t of fish would have to be transported by trucks. The number of trucks required to dispose of an average daily production of 135 t would be 45 of 6 t capacity which effectively transport iced fish. Taking the average distances travelled by a truck to dispose of the fish to be 200 km, each truck could take the load only on alternate days. Thus the actual number of trucks required would be 90 for a one year period and these could be provided at the important ports. Guidelines for regionwise distribution can be had from the table giving the expected distribution of landings.

Development of marketing system

Eventhough need based arrangements for the marketing of fish in the country are in vogue, the system has to be further developed according to future needs by adopting proper management strategies. The fishermen's co-operatives which at present are not a force in themselves are to be strengthened/ established in every major fish landing centre, so that many of the intermediaries could be avoided thus promisjng legitimate returns to the fishermen for their catches.

At present flow of fresh fish into the interior areas is rather poor for lack of proper transport and storage facilities. The fish that reaches the interior markets is often partly spoiled. If adequate facilities for transportation (insulated/refrigerated trucks) and cold storages at the markets are available, more quantities of fresh fish could moved to far interior areas and marketed. Therefore a chain of cold storages of appropriate capacities, based on the local demand as ascertained through consumer surveys, are to be established (cold chain') on a country wide level.

With the exploitation of the oceanic waters considerable quantities of non-conventional but edible resources like *Chlorophthalmus* spp., *Priacenthus* sp. and *Centrolophus* sp. may be landed which may not be readily accepted by the consumers. However, if minced fish popularly known as "fish kheema" is produced marketing may not be a problem. Mention has already been made of the several such products which can be developed.

Along with the diversification of fishery products, acceptance of the products by the public is to be ascertained. In the absence of a true picture of the marketing conditions it is difficult to precisely spell out the infrastructural requirements like cold storages, drying plants, fish meal plants and the transport systems. Comprehensive market surveys are to be conducted to ascertain the cold chain centres, capacity and number of cold storages drying facilities and routes, modes and capacity of transport system to be established for the purpose. Along with this, conumer education has to be organised for making people aware of the diversified products and their qualities.

In seasons of heavy fish catches the price of fish comes down alarmingly and this leads to poor returns to the fisherman. During such times the governmental agencies or marketing societies should enter into the market and purchase the excess fish at reasonable price and store for the lean periods. Also it is necessary that minimum support price for all varieties of fish may be fixed so that fishermen are assured of proper returns for their commodity. Such a system will encourage fishermen to land all what they catch (trash and non-conventional fish) which other wise they throw back into the sea.

CONCLUSIONS

Since early fifties marine fish production in the country rose steadily from 0.5 million tonnes and crossed the one million mark in 1970 due to several R & D inputs. However during the mid-seventies the production reached a plateau and remained so until early eighties. The present production is of the order of 1.6 million tonnes.

Based on different approaches such as the estimates of primary production, trophic relationship, exploratory fishing, acoustic survey and exploited resources, the potential of harvestable yield of fishes in the EEZ of India was estimated at 4.5 million tonnes. Accepting this as the basic figure of the potential yield it is seen that the present production in the country leaves an un-exploited stock of about 2.9 million tonnes. This calls for immediate strategies for harvesting the additional quantities in the coming years in a phased manner. Towards the development of such a strategy an attempt has been made in this paper to bring together background information on the region-wise exploited stocks, categorywise potential resources, available infrastructure, pattern of utilisation and marketing aspects. The projection with regard to expected additional yield, infrastructure needed to achieve the targeted production and the economics of vessel operations are presented. Utilisation and marketing requirements are also discussed.

The fishing pressure at present both from artisanal and small-scale sector is mainly within the 50 m depth. It is pointed out that additional increase from this zone will be only marginal except in the case of some of the underexploited resources like white-baits and horse-mackerel. However, extension of fishing activities beyond 50 m over the shelf region will bring an additional yield in the case of resources such as small tunas, catfish, horse mackerel & scads, perches and ribbon-fish.

There are good prospects, as revealed by exploratory surveys, for the harvest of resources such as larger perches (*Epinephelus* spp., *Lethrinus* spp , *Lutjaneus, pristipoma* spp). from the banks and rocky out-growth off the west coast. Deep sea crustaceans comprising deep sea lobster and penaeid prawns from the continental slope and a variety of non-conventional edible finfishes such as bull's eye, Indian drift fish green eye and the black ruff as well as miscellaneous fishes like rat tails and boar fishes are available from the deeper trawling grounds

Over and above this, the potential for exploitation of larger tunas, pelagic sharks, marlins and oceanic squids, is promising from oceanic waters including the island territories of the Andaman, Nicobar and Lakshadweep. These remain virtually un-tapped at present.

Considering the fact that it has taken more than two decades to realise an additional production of one million tonnes from the level of 0 5 million tonnes in the fifties despite the steady increase in development inputs, the strategy suggested in the paper envisages introduction of additional production means and infrastructure in a phased manner, in keeping with the current realities. Attention is also drawn to the gaps in information observed in certain critical areas.

The proposed plan is summarised below with suitable recommendations.

1. In order to harvest a part of the exploitable resources, the plan is to introduce 160 additional vessels comprising 65 small purse-seiners (13.6m), 55 medium trawlers (17.5m) and 40 large trawlers (26m) during a one year period. This would result in about 0.11 million t of additional yield from the shelf and slope areas. The species-wise disribution of the expected additional yield is given in Table 7. The total investment for the purchase of crafts and gears would be about Rs. 647 million out of which Rs. 400 million would be for the large trawlers alone.

The region-wise distribution of additional vessels required for exploitation of different categories for a one year period is indicated along with suggestions for suitable gears to be operated (Table 8).

The plan envisages progressive introduction of vessels leading to an additional annual production of about 0 55 million t in the filth year and this would result in harvesting of 5·60 percent of the exploitable yield of the selected resources.

The target resource considered are white baits, costal tunas, elasmobranchs, cat fish, perches, croakers, ribbonfish, carangids, crustaceans and cephalopods. However for the oceanic tunas and cephalopods no estimate of projected catch and number of vessels is included in the figures stated due to want of critical data (also see item 9 under 'Conclusion').

2. The addition of vessels should be made in a phased manner with some amount of flexibility. The performance should be monitored and critical appraisal should be made year after year using feed back data on the achievements. Suitable modifications may be made, if need be, to suit the developing situation.

3. With the progressive increase in the number of vessels the requirement of trained men also increases. It is estimated that a total of about 1950 trained personel including skippers and chief engineers would be required for a one year period to operate the proposed number of vessels (Table 9).

4. Deep sea non-conventional fishes obtained as part of the catch should be brought to the shore as they offer good potential for conversion to edible products or reduction to fish meal and manure.

Towards better utlisation of non-conventional and new resources the technological institutions should undertake product development for consumer acceptance covering a wide range of resources.

5. In the case of the three major categories of fishing units proposed, namely purse seiners (13.6 m), medium trawlers (17.5 m) and large trawlers (26.0 m) the projected economics of operations have been worked out and found to be commercially feasible (Tables 10 to 13).

6 To ensure additional production and bringing in unconventional fishes, it is desirable to declare remunerative support price of different varieties of fish landed. Fish co-operatives could be the best agency for deciding and implementing such a programme.

7. The suggested modalities of increasing fish production in a phased manner should take into account the required infrastructure development in terms of landings, berthing, ice-plants, cold storages, fish processing plants, fish drying units, transportation and marketing. The problems involved have been broadly considered and indications have been given on future needs.

In order to make more specific recommendation about the location of cold-chains, processing plants and transportation routes and to understand the consumer behaviour and the changing demand-supply position, it is essential to carry out periodic market surveys at micro and macro levels.

8. Bulk of the coastal tuna catches currently come from the small-scale fisheries sector using drift gillnets and hooks and lines. With the increasing trend in motorisation of country crafts it is time to introduce innovations in the country craft and gear to enhance fishing capabilities and to provide icing and storage facility onboard.

In the Lakshadweep area, the existing mechanised pole and line units can be improved by introducing larger boats with adequate storage and navigational facilities.

9. There is considerable potential for the exploitation of oceanic tunas and related species. However, so far, only the skipjack and young yellowfin tunas occurring in the Lakshadweep waters are exploited and that too in small quantities through small mechanised units using pole and line. The exploratory cruises of the Govt. of India vessels have shown possibilities of tuna long lining in commercial quantities from our seas. But the data provided have shown highly varying hooking rates and it becomes difficult to project economic viability of such operations. Considering these, a table has been constructed (Table 15) indicating the expected profits in long-line operations for various combinations of tuna catch level and unit price. This would help in providing guidelines for decision making.

In the case of cephalopods, increased catches can be made by directed effort on the neritic resources and extending the fishing activities to deeper areas. Specific fishing methods such as squid-jigging, light fishing and drift gill netting are suggested as appropriate techniques and some of these require expertise from countries like Japan.

Distant water fishing using long-liners, purse-seiners and squid-jiggers, being a highly capital intensive venture in terms of cost of vessels, fishing equipments and operations, an adequate return for the investment depends on high productivity from the operations as well as easy and profitable sale of catches in internal and external markets. Expertise in fishing operations is an important contributing factor in increasing the productivity. It is desirable to have more joint ventures and/or chartering of foreign vessels at least for some more time to come so as to enchance production. develop expertise, generate confidence and make the industry economically viable.

10. In developing suitable programmes for tapping the resources it is essential that Government of India vessels undertake systematic simulated commercial fishing for target resources by different types of fishing operations. Such operations would generate a good amount of data essentially needed to confirm areas and season of fishing and arrive at the number of deep-sea vessels such as long-liners purseseiners and squid-jiggers needed to economically exploit the oceanic tunas, tuna like species and cephalopods.

11. The export trade in our country has so far been concentrating mainly on the limited stocks of coastal shrimps even though fish exports have of late been increasing. Future strategies therefore require diversification of this export trade in much bigger way by bringing in varieties of fishes apart from crustaceans, squids and cuttle fish.

12. Most of our resources are known to exhibit seasonal fluctuations which are due to fishery independent factors. There is urgent need for integrating environmental data with resources data. At present a number of organisation are engaged in the collection of enviromental and exploratory fisheries data. It is suggested that the vessel facilities available with the different organisations under the Govt of India are pooled together to undertake surveys of the resources and environmental studies in different regions Bringing the vessel-based programmes under one umbrella will almost eliminate duplication of efforts and permit more efficient use of the scarce resources of vessel and specialised man power facility. The concurrent information generated on the fishery dependent and independent factors, would permit better understanding of the potential stocks in the EEZ and the contiguous seas and help not only in making short and long term fisheries forecasting but also in formulating sound management policies.

It should be mandatory that the joint venture/chartered vessels and large vessels of private enterprises must collect some minimum environmental data and provide the same along with the data on exploited resources to the concerned central organisations so as to carry out integrated analyses for better appreciation of the dynamics involved.

13. An essential component of the development strategy in marine fisheries sector is a strong data base relating to the various stages of production and distribution. For this purpose the C. M. F. R. I. has developed a National Marine Living Resources Data Centre at its headquarters with fishery and computer expertise. The centre forms an excellent store-house for all fisheries data which would help in co-ordination of research and allied activities in the marine fisheries sector. Data flow to NMLRDC from all organisations and industry should be ensured for quick processing and dissemination at national level. A mandatory provision has to be introduced for this purpose.

14. Knowledge about the specific distribution of potential marine resources, provision of improved means of production, development of infrastructure facilities for landing, storage, processing, transporting and marketing, meeting the requirements of man power and credit and a sound policy for judicious exploitation are some of the major aspects concerned

with the development of marine fisheries. Thus the total marine fisheries system has to be viewed as one comprising of several interlinking sub-systems. In order to achieve the best results a system approach has to be followed in any future strategy for exploitation and utilization of our vast marine living resources. There has been much thinking about the formation of a Marine Fisheries Development Board at the national level with adequate powers. Such a Board can co ordinate the activities of the various sub systems involved and ensure timely and effective implementation of the development programmes It would be appropriate to consider creation of a Ministry of Fisheries to administer all activities covering the fisheries of the country.

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