LAKFISH

INTEGRATED PERSPECTIVE PLAN FOR FISHERIES DEVELOPMENT OF LAKSHADWEEP

Central Marine Fisheries Research Institute, Kochi
Central Institute of Fisheries Technology, Kochi
Indian Council of Agricultural Research, New Delhi

March 2006

Contents

Acronyms used

CIFNET	Central Institute Fisheries Nautical Engineering Technology
CIFT	Central Institute of Fisheries Technology
CMFRI	Central Marine Fisheries Research Institute
CSMCRI	Central Salt & Marine Chemicals Research Institute
DA	Dearness Allowance
DoF	Director of Fisheries
DAHD&F	Department of Animal Husbandry, Dairying and Fisheries
DGN	Drift Gill Netting
EOU	Export Oriented Unit
FADs	Fish Aggregating Devices
FRP	Fibre Reinforced Plastic
FSI	Fishery Survey of India
FTC	Fisheries Training Centre
EEZ	Exclusive Economic Zone
GIS	Geographic Information System
GPS	Global Position System
GR	Gross Revenue
HL	Hook & line
IRDP	Integrated Rural Development Programme
ICAR	Indian Council of Agricultural Research
IUCN	International Union for Conservation of Natural resources
LDCL	Lakshadweep Development Corporation
LL	Long lining
MCS	Monitoring, Control and Surveillance
MFR 2000	The Lakshadweep Marine Fishing Regulation 2000
MPEDA	Marine Products Export Development Authority
NIOT	National Institute of Ocean Technology
NRSA	National Remote Sensing Agency
OC	Operating Cost
PUF	Polyurethane foam
PFZ	Pelagic Fisheries Zone
R&D	Research and Development
SEAFDEC	South East Asian Fisheries Development Centre
SCICI	Shipping Credit Investment Company of India
SHGs	Self Help Groups
TA	Travel Allowance
TC	Total cost
VHF	Very High Frequency

About this document

The administrator of the UT of Lakshadweep approached the Indian Council of Agricultural Research (ICAR), New Delhi to expound an integrated plan for fisheries and agricultural development in Lakshadweep keeping in view the potential resources, limited land availability, the livelihood and employment opportunities of the stakeholders in the islands and the current trends in global fisheries development. In response to this, the Deputy Director General (Fisheries) of the ICAR specifically requested the Central Marine Fisheries Research Institute (CMFRI), Cochin, Central Institute of Fisheries Technology (CIFT), Cochin, to jointly work out a master plan for development of fisheries of Lakshadweep, covering aspects of coastal and oceanic fisheries, fishing technology, post harvest handling and processing and open sea mariculture for the next ten years.

The present document code named ***LAKFISH*** is the outcome of several joint sittings made by the Directors and scientists of CMFRI and CIFT, and Department of Fisheries, Lakshadweep. This document has been prepared by considering the feasibility report by Indian Institute of Management (Kozhikode) and the issues raised by the Administrator, Lakshadweep Islands. This document has also taken into consideration the recommendations of various committees, the information available from the ongoing R&D efforts of CMFRI and CIFT and study reports on fisheries development in the Lakshadweep islands.

The following scientists and officials were involved in the preparation of this document:

CMFRI, Cochin

1. Prof. (Dr.) Mohan Joseph Modayil, Director
2. Dr. N.G.K. Pillai, Head, Pelagic Fisheries Division
3. Dr. E. Vivekanandan, Head, Demersal Fisheries Division
4. Dr. R. Sathiadhas, Head, Socio Economic Evaluation and Technology Transfer Division
5. Dr. K. Sunil Kumar Mohamed, Head, Molluscan Fisheries Division
6. Shri. K.P. Said Koya, Scientist-in-charge, Minicoy RC of CMFRI

CIFT, Cochin

1. Dr. K. Devadasan, Director
2. Dr. K.G. Ramachandran Nair, Head of Division
3. Dr. B. Meenakumari, Head of Division
4. Dr. P.K. Vijayan, Principal Scientist
5. Dr. Jose Joseph, Principal Scientist
6. Dr. P. Pravin, Senior Scientist
7. Shri M.V. Baiju, Naval Architect

Department of Fisheries, Lakshadweep Administration

1. Shri A.K. Wasnik, IAS, Secretary, Fisheries
2. Dr. M.S. Syed Ismail Koya, Director of Fisheries
3. Shri. M.C. Muthukoya, Asst. Director of Fisheries

ICAR Fisheries Division, New Delhi.

Dr. S. Ayyappan, Deputy Director General (Fy.)

Final Document Consolidation

1. Dr. N.G.K. Pillai, CMFRI
2. Dr. E.Vivekanandan, CMFRI
3. Dr. Sunil Kumar Mohamed, CMFRI
4. Dr. R. Sathiadhas, CMFRI

Executive summary

LAKFISH is an integrated perspective plan for the development of fisheries in Lakshadweep Islands. The document has been prepared by Central Marine Fisheries Research Institute and Central Institute of Fisheries Technology in response to request to the Indian Council of Agricultural Research by the Administrator of the Islands. *LAKFISH* proposes development of lagoon and oceanic fisheries, fishing technology, processing, mariculture and ecotourism in 3 phases from 2006-07 to 2016-17. The plan proposes utilizing 62% of the potential yield of about 1,00,000 tonnes of fish resources from the present level of 10% by investing **Rs. 189.41 crores**. The anticipated annual gross revenue in phase III is Rs. 555 crores. The major recommendations under different sections are given below:

Capture Fisheries

- The mechanism of fish landings data collection should be improved and the potential yield estimates need to be revalidated.

- Fish production in Lakshadweep could be increased in the following ways: i) Upgradation of existing fishing craft (traditional units, pole & line units, gillnetter-cum-troll lines), ii) Introduction of new craft (tuna longline-cum-gillnetter for *Sashimi* grade tuna, Maldivian type pole and line craft, Mother/Collector vessels, iii) Modernization of fishing gear, iv) Improving the communication network and v) Installation of FAD's.

- Upgradation of existing boats involves FRP lamination of underwater hull, providing live bait tanks, insulated fish box and solar panels in the boats. The investment for upgradation is Rs. 752 lakhs.

- Introduction of modern new vessels is expected to increase the quantity of fish catch as well as facilitate production of value-added items for export. It is recommended to introduce 100 pole and line units, 50 troll line-cum-gill net units, 10 tuna longliner-cum-gillnetters, 100 Maldivian type of pole and line vessels and

2 mother vessels at an investment of Rs. 13,007 lakhs, which is about 70 % of the proposed total investment.

- Large mesh drift gillnets, monolines and troll lines for large pelagics and traps for lobsters, demersal fishes, ornamental fishes and octopus are suggested.
- In this approach, the annual fish landing is expected to increase to 17,325 t in phase I, 41,675 t in phase II and 62,075 t in phase III.

Processing tuna

- Several tuna products such *sashimi* grade tuna, chilled, smoked and frozen tuna loins, high quality *masmin* and shark products are proposed for export. The export is anticipated to fetch Rs. 37,516 lakhs annually in phase III.
- A modern canning plant at an investment of Rs. 245 lakhs is recommended
- Six waste-utilization units for conversion of fish wastes into organic manures are suggested.

Mariculture

- Ideal situation exists for raft, cage and pen culture in the lagoons. The potential sites are off Kalpeni, Bangaram and Minicoy. Finfishes, marine ornamentals, lobsters, pearl oysters, giant clams, octopus, sea cucumbers and seaweeds can be farmed. Tuna fattening is also recommended. An investment of Rs. 811 lakhs is suggested for the development of mariculture.

Marketing

- Lakshadweep Development Corporation Ltd. (LDCL) may develop tie-up with Government fisheries agencies in Kerala and Karnataka to make use of their cold storage facilities in the main land to store and market the catch from Lakshadweep.
- Retail outlets for Lakshadweep brand tunas and tuna products may be started in the metros and major cities of India.

Eco-tourism

- There is great scope of eco-tourism. One oceanarium in Kavarati, 5 sport-fishing vessels and 5 glass bottom boats are suggested at an investment of Rs. 1225 lakhs.

Research Programmes

- A strong research support in capture fisheries, fish processing, mariculture and environmental issues in collaboration with CMFRI, CIFT, FSI, IFP and MPEDA is suggested. A total of Rs.1000 lakhs is recommended for this purpose during the three phases.

Human Resource Development

- Training and demonstration programmes in craft and gear technology, fish processing and mariculture are suggested for the benefit of the Islanders.

Administrative policies

- Total revamping of Department of Fisheries with increased funds, manpower and autonomy is recommended.
- Strict licensing and effective monitoring, control and surveillance of fishing vessels are important.
- The administration may consider 20% incentive on capital cost of new fishing boats as the first step, which may be later revised based on the response from private investors.

Projected phase-wise investment profile (Rs. In lakhs) for development of fisheries in Lakshadweep Islands

Development programmes	Phase - I	Phase - II	Phase - III	Total
Upgradation of Existing boats	752	-	-	752
Introduction of New Vessels	800	4657	7550	13007
Mariculture development	270	285	256	811
Processing facilities	1152	272	222	1646
Eco-tourism	1090	135	-	1225
Research programmes	400	300	300	1000
Human Resource Development	250	130	120	500
Total	4714	5779	8448	18941

1. STATUS OF FISHERIES

Preamble

The Union Territory of Lakshadweep, consisting of eleven inhabited and 25 uninhabited islands, is scattered in the Arabian Sea at about 200-400 km from the Malabar Coast. The islands are distributed between 08°00'N and 12°30'N latitudes and 71°00'E and 74°00'E longitudes. The remoteness of the islands from the mainland has forced the inhabitants to live in isolation amidst poverty, ignorance and ill health. Coconut and fish form the mainstay of the economy of the islanders. The lagoons and the surrounding waters are replete with a wide variety of flora and fauna. The tunas and other food fishes are being exploited ever since human settlement. The islands became a Union Territory of India in 1956 and it was named Lakshadweep in 1973. Since then there has been rapid progress especially in the fields of agriculture, fisheries, education, health etc. Next in importance to agriculture, the fisheries sector plays an important role in the economy of the islands.

The archipelago consists of 12 atolls, three reefs and five submerged banks. There are 36 islands covering an area of 32 sq. km. Of these, only 11 islands (Fig.1) namely, Androth, Amini, Agatti, Bitra, Chetlat, Kadmat, Kalpeni, Kavaratti, Kiltan, Minicoy and Bangaram are inhabited. Among the uninhabited islands, Suheli is a coconut growing and fishing centre. Pitti or the bird island is small reef with sand bank covering an area of 1.2 hectare lying northwest of Kavaratti where terns in thousands visit for nesting and is designated as a bird sanctuary. The details of inhabited islands are given in Table 1.

Except Androth, all the islands have a lagoon, some of which are fast getting filled up by calcareous sand. Bitra has perhaps the most magnificent lagoon. Minicoy has a large and deep lagoon with a boat channel on the northern side giving safe access and anchorage to vessels of about 3 m draught. The outer edges of atolls drop precipitously to the ocean floor. Mostly on the eastern side the atolls overhang the precipitous shelf. The eastern side is generally more sheltered from wind and current. The islands, ranging in area from 1 ha

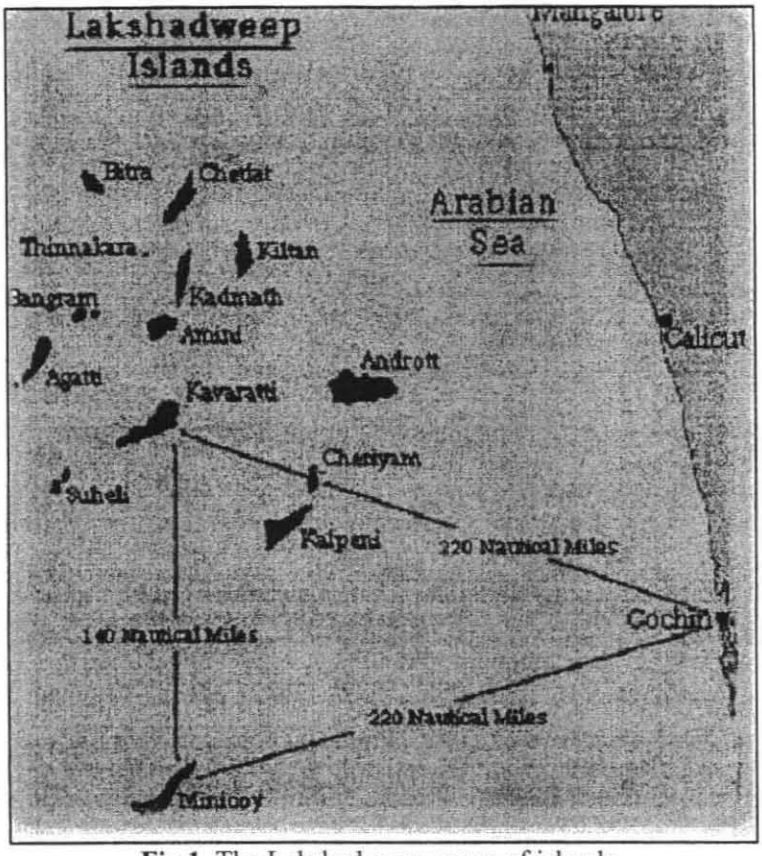

Fig 1. The Lakshadweep group of islands

to nearly 440 ha are little specks in the Indian Ocean. They are beautiful, idyllic and strategically located from the point of view of economic and defence considerations of India. Being oceanic islands, the continental shelf around them is limited to about 4336 sq.km. But considering the lagoon area of about 4200 sq.km, 20,000 sq.km. of territorial waters and about 400,000 sq.km. of oceanic zone, Lakshadweep is one of the largest oceanic territories of our nation.

Table 1. The names and details of the inhabited islands in the UT of Lakshadweep

Sl. No	Name of Island	Geographic Location	Area in Sq.Km	Lagoon area sq.Km
1	Agatti	Lat.10°51' N; Long.72°11'E	3.84	17.50
2	Amini	Lat.11°07' N; Long.72°44'E	2.60	1.50
3	Androth	Lat.10°49' N; Long.73°41'E	4.90	-
4	Bitra	Lat.11°36' N; Long.72°10'E	0.10	45.61
5	Chetlat	Lat.11°41' N; Long.72°43'E	1.40	1.60
6	Kadmat	Lat.11°13' N; Long.73°39'E	3.20	37.50
7	Kalpeni	Lat.10°05' N; Long.72°11'E	2.79	25.60
8	Kavaratti	Lat.10°33' N; Long.72°38'E	4.22	4.96
9	Kiltan	Lat.11°29' N; Long.73°E	2.20	1.76
10	Minicoy	Lat.8°17' N; Long.73°04'E	4.80	30.60
11	Bangaram	Lat.10°56'N Long.72°17'E	0.58	60

1.1. Fishery Resources

The fishery resources of the islands comprising the oceanic resources such as the tunas, billfishes pelagic sharks etc., and the other groups of food fishes, live baits and ornamental fishes inhabiting the reefs and numerous lagoons play a vital role in the economy of the islands. The fishery activities in Lakshadweep are concentrated in all the 11 inhabited islands and in the uninhabited island - Suheli. The main resource exploited is tuna and tuna-like fishes. Following are the tuna species commonly seen in Lakshadweep waters:

1. *Katsuwonus pelamis* (Skipjack tuna)
2. *Thunnus albacares* (Yellowfin tuna)
3. *Auxis thazard* (Frigate tuna)
4. *Euthynnus affinis* (Little tunny)

Of these, *Katsuwonus pelamis* is the major species on which the commercial fishery is established. In addition to the tunas, flying fishes, barracuda, seerfish, sail fish, dolphin fish, rainbow runner, gar fishes, half beaks, snappers, perches and other reef fishes, sharks, rays, trigger fishes, octopus etc. also form fishery. About 601 species of fishes have been recorded in the Lakshadweep waters by CMFRI. It is estimated that the annual catchable potential yield of tunas is about 50,000 tonnes of tunas and an equal quantity of other fishes are available. The annual total landing is about 10,000 tonnes, which is only about 10% of the estimated fishable potential.

1.2. Fishing Methods

I'he main fishing method practiced is pole and line for tuna by using live bait. The operation is conducted from specially designed mechanised boats of 25' to 34' overall length (OAL). About 510 mechanised tuna pole and line fishing boats have been introduced so far. Out of these, 350 to 400 boats are actively engaged in fishing now. Pole and line fishing is done in all the islands except in Androth. In Androth, other methods such as trolling, hook and line, gill nets, long line etc. are used for fishing. Long lining for shark is also practiced, engaging mechanized boats. However, due to higher returns from tuna fishing compared to shark fishing, very few fishermen have opted for long lining for sharks. Besides there are about 900 country crafts which includes crafts fitted with outboard motors using troll line, hook and line, gill nets, long line etc. to catch other fishes.

Consequent to the successful introduction of mechanised boats for pole and line and other fishing, demand for boats increased. To meet the requirement and with an objective of employment generation, two boat building yards one each at Kavaratti and Chetlat have been established for construction of mechanised fishing boats. Under this programme 510 number of mechanised fishing boats have been supplied to the fisherman of various islands so far under hire purchase system (Table 2). This helped to increase the fish production from 500 tonnes per annum in the 1960s to the present level of about 10,000 tonnes per annum.

Table 2.Island wise availability of fishing boats

Island	Country crafts	Mechanised boats
Agatti	151	130
Amini	51	43
Androth	49	36
Bitra	16	9
Chethlat	31	34
Kadmat	100	26
Kalpeni	85	33
Kavaratti	260	89
Kiltan	40	60
Minicoy	137	50
Total	918	510

1.3. Live bait resources

Live bait fishes are used for chumming and attracting tuna shoals and are essential for tuna pole line fishing. The live baits are caught from the coral reef and lagoon of different islands. There are about 21 species of live baits available in Lakshadweep waters. Over a dozen species are used in the fishing. The most common species in the order of abundance are *Spratelloides delicatulus, S. japonicus, Apogon sangiensis, A. savayensis* and *Chromis ternatensis*. Fishermen do report scarcity of live baits occasionally.

1.4. Present status of capture fisheries

Fish landings by year and Island are given in Tables 3 and 4, respectively. The major fish landings is at Agatti, Suheli, Minicoy, Bitra and Androth.

Table 3. Fish landings in Lakshadweep for the last 10 years (in tonnes)

Year	Shark	Tuna	Miscellaneous	Total
1995	261	8250	717	9887
1996	119	8798	802	10250
1997	221	8072	1119	10412
1998	980	12308	899	14615
1999	139	7624	4188	13081
2000	145	7071	1604	10082
2001	75	9343	2382	12800
2002	62	6656	1014	9149
2003	84	8149	551	10080
2004	77	8232	790	10512
Average	216.3	8450.3	1406.6	11086.8

Table 4. Island-wise fish landing during 1992-2001 (in tonnes)

Item	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Average
Kavaratti	2011	1746	1150	1199	1292	2073	2031	1778	696	1179	1516
Agatti	1914	3131	1749	2196	2625	2307	2276	3244	2905	2995	2534
Amini	359	629	496	278	374	566	605	712	321	371	471
Kadmat	230	251	246	300	439	673	822	745	496	456	466
Kiltan	519	542	622	772	530	482	1134	1191	1130	1363	829
Chetlat	450	502	359	411	350	529	638	887	958	1057	614
Bitra	987	285	416	382	340	415	884	348	416	1268	574
Androth	603	964	1293	1364	1541	1535	1470	1310	1125	1230	1244
Kalpeni	158	266	280	192	270	470	513	485	314	314	326
Minicoy	955	1089	953	1326	1193	1152	2638	2575	1027	1313	1422
Suheli	2281	-	-	1575	1296	153	1615	705	694	1254	957
Total	8186	9405	9845	9995	10250	10355	14626	13980	10082	12800	10953

1.4.1.Tuna fishery

Introduction of mechanisation in the early 60's has resulted in the increase of tuna production at Minicoy, where a traditional fishery employing *'Masodis'* was in existence. Coupled with this, the spread of pole and line fishing practice off the northern islands Agatti, Bangaram, Perumul Par, Suheli and Bitra has resulted in the production of tuna from a few hundred tonnes in the 60's to about 12,300 tonnes in 1998.

Whereas the pole and line live-bait fishery is practiced during the non-monsoon months (September to May), surface trolling for yellowfin, skipjack and billfishes is practiced especially during the monsoon period.

During the period 1980 to 2004, annual tuna landings in the Lakshadweep islands ranged between 1,760 t (1980) and 12,300 t (1998) with an average of 6,339 t (Fig.2) against a projected annual potential varying between 50,000 and 90,000 t. The major

contribution to the tuna landings comes from Agatti (31%), Suheli (14%), Minicoy (17%), Kavarati and Androth (8%) (Fig.3). Compared to the tuna catch of neighboring island nations such as Maldives (1,48,500 t) and Sri Lanka (27,000 t), the catches from Lakshadweep are very low.

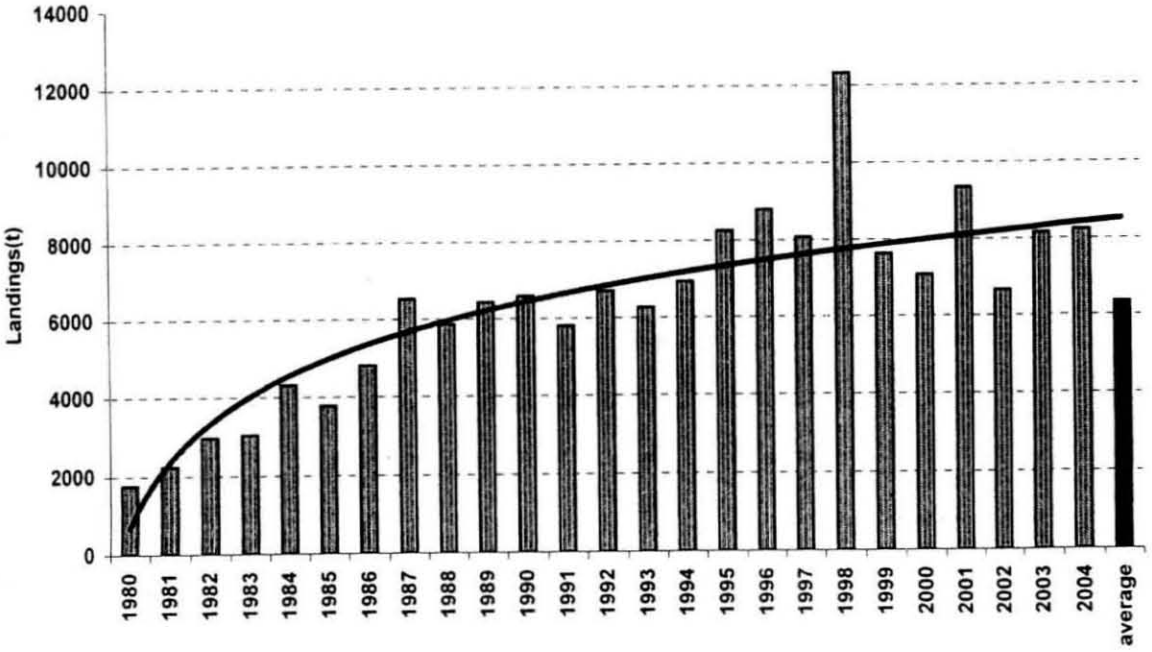

Fig 2. Tuna landing from Lakshadweep during 1980-2004

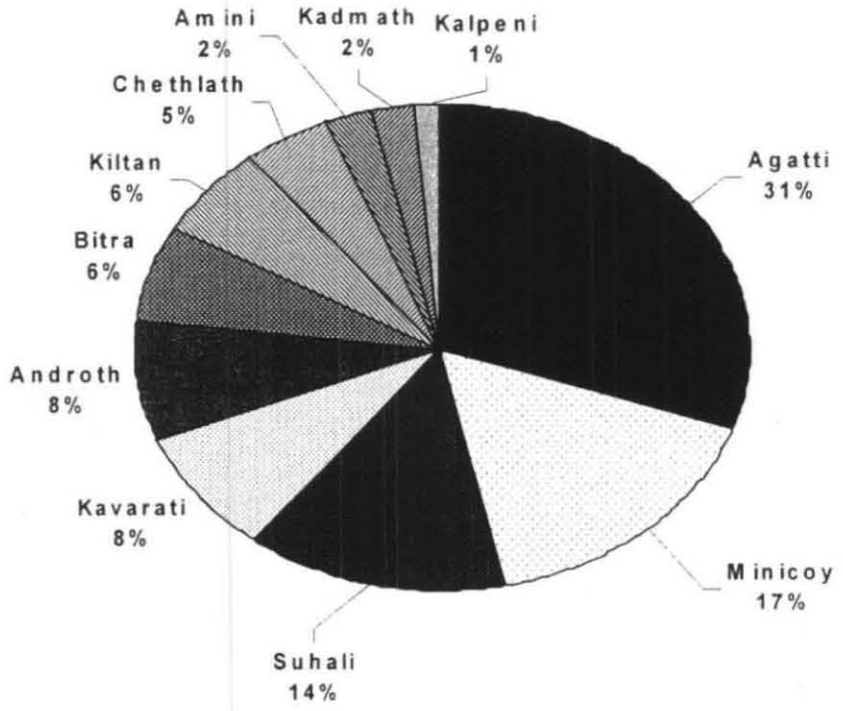

Fig.3. Island-wise tuna landings during 1980-2001 (average)

Potential resources of tunas in the seas around Lakshadweep has been estimated to be 50,000 tonnes by George *et.al.*, (1977) and 90,000 tonnes by Chidambaram (1987). But the average production for the last ten years is only about 6,000 tonnes. Many earlier workers have proposed strategies for development and management of tuna fishery to increase the production.

The major tuna species landed (1980-2001 average) was *K. pelamis* (86%) followed by *T. albacares* (12%) and the rest was *E. affinis*. Pole & lines account for 97% of the total tuna landings followed by troll lines. About 300 boats are annually in operation for pole and line tuna fishing during the last 15 years. Pole & line-fishing boats (OAL of 25-36') mostly conduct single day fishing trips and often operate 2 trips during the peak season. The difficulty in maneuvering larger sized boats within the lagoon is perceived as bottleneck in introducing larger boats with higher fish hold capacity. Though there has been wide annual fluctuations in catch and catch per unit effort, catch per unit effort and the mean length in the fishery have not undergone any significant change. Since 1994, tuna

catches and catch rates from Androth have increased due to adoption of drift gillnetting as well as fishing in distant fishing grounds such as Elikalpeni Bank.

Artificial baits (plastic strips suspended on two or three rows on which water is splashed to create an impression of live baits) were tried on an experimental scale during 2002 off Minicoy but had limited success compared to live-baits.

Fish Aggregating Devices (FADs) were introduced in Lakshadweep waters in 2002 in the open sea as well as in the lagoons to aggregate fishes by the CMFRI under a World Bank Programme. Data buoys for Arabian Sea Monsoon Experiments- Phase-II deployed by the National Institute of Ocean Technology (NIOT), 16-26 nautical miles off Minicoy and Kavaratti are functioning as FADs aggregating tunas as well as other fishes. It is observed that young tunas aggregate in large numbers than the adults. However, assured catches from the FAD sites made the fishermen to venture to these distant fishing grounds with GPS.

Utilization

At Lakshadweep over 85% of the total landings constitute tunas of which about 50% of the total tuna landings is used for *'Masmin'* production and the remaining 50% consumed fresh. Presently *Masmin* is prepared by traditional way by cutting tuna in to longitudinal fillets, boiling in seawater, smoking and then sun drying for about 7 - 8 days. In recent years, frozen tuna export and tuna pickle preparation is being promoted by the Lakshadweep Development Corporation (LDCL).

1.4.2.Ornamental Fishes

Of the total 600 marine fishes known from the Lakshadweep waters, over 300 species belonging to about 35 families are known for their attractive colour and shapes and can be termed as ornamental fishes for aquarium keeping. A recent survey conducted by the CMFRI indicated that, 20 of the 35 families are common and are represented by 252 species (Table 5). Among these, 165 species constitute the major ornamental fishes and have great demand in the ornamental fish trade.

Table 5. Details of the number of species known and collected in the survey conducted by CMFRI during 1993-1997 from Lakshadweep.

S.No.	Family	Popular Name	Number of species	
			Known	Collected
1.	Acanthuridae	Surgeon fish	20	17
2.	Apogonidae	Cardinal fish	22	9
3.	Balistidae	Trigger fish	10	6
4.	Canthigasteridae	Puffer fish	4	2
5.	Chaetodontidae	Butterfly fish	18	14
6.	Holocentridae	Squirrel fish	11	11
7.	Labridae	Wrasses	42	32
8.	Monocanthidae	File fish	7	2
9.	Mugiloididae	Sandsmelt	2	2
10.	Mullidae	Goat fish	14	10
11.	Pomacanthidae	Angels	2	2
12.	Pomacentridae	Damsel fish	35	26
13.	Ostraciontidae	Box fish	4	1
14.	Scaridae	Parrot fish	15	12
15.	Scorpaenidae	Scorpion fish	14	3
16.	Serranidae	Rockcod	21	9
17.	Siganidae	Rabbit fish	3	3
18.	Synodontidae	Lizard fish	2	1
19.	Tetradontidae	Puffer fish	5	2
20.	Zanchidae	Moorish idol	1	1
	Total		252	165

Source: *Murty, V.S.2002. Marine Ornamental Fish Resources of Lakshadweep. CMFRI, Spl. Pub. 72: 134 pp.*

2. PHILOSOPHY OF APPROACH

The development of Lakshadweep has been severely affected by limitation in the land area, drinking water and energy. This factor underlines the need for devising fisheries development plan by giving emphasis on sea-based programmes. The communities have unique social, economic and cultural framework, which is different from that of the mainlanders. The beliefs and mental blocks against the mainlanders prevent free movement, and fishing ventures have so far retained the identity of the islanders, and hampered the development of the islands. There are interisland conflicts and fishermen from one Island do not permit other Islanders to fish in their waters. This document has been prepared by taking into consideration these important aspects. The uniqueness of each island has also been considered and specific development agenda has been recommended. The reports and recommendations of earlier committees have also been consulted for preparing this document. The important research findings of Minicoy Research Centre of CMFRI have also been considered for developing the road map.

The approach to the plan is by considering different scenarios such as increasing production, employment and income with the existing infrastructure facilities, and by upgrading the facilities at different levels. The major approach of this document for increasing production and income is through sustainable capture fisheries, open sea mariculture, improved processing and value addition, and by ensuring better marketing and value realization.

The time-line for the road map is the last year of X plan (2006-07) and the whole of the XI (2007-12) and XII Plans (2012-17), thus for a total period of 11 years.

Keeping the revalidated potential yield as a base, a target exploitation of 17 % of the potential by March 2010, 42% by March 2013 and 62% by March 2017 has been set.

Quantities of fish yield were projected as per the above targets and the required craft, gear, storage, handling processing, other related infrastructure and amenities were

assessed and investments needed projected on the time-line. Proposed additional fishing crafts and gear facility required in each phase is given below (Table 6):

Table 6 : Proposed additional fishing crafts and gear facility required in each phase

Sl.No.	Facilities required	Phases		
		I	II	III
1.	Upgradation of existing: i. Traditional fishing crafts ii. Pole & Line boats (28 - 33') iii. Troll line-cum-gill netters	 150 units 300 units 100 units	 -	 -
2.	i. Introduction of pole and line units ii. Gill netter/Troll lines	- -	100 50	- -
3.	Introduction of Maldivian type Pole & Line boat	-	50	50
4.	Introduction of Long liner-cum-gill netter	-	3	7
5.	Mother ship / Collector vessel	1	-	1
6.	With adequate Processing facilities proportionate to the catch	Shown under Section **6**		

This logical approach provided an avenue for informed and planned overall development.

The total anticipated investment to the tune of nearly **Rs. 189.41 crores** will facilitate not only the exploitation of about **62% of the potential resources**, but also will result in the development of open sea mariculture and marine resource conservation programmes.

It is expected that mid-course reviews and revisions would take place during the implementation process.

3. MAJOR ISSUES AND CRITICAL FACTORS

3.1. Major issues

3.1.1. Capture Fisheries

1. Data availability on fish landings/fishery resources inadequate
2. Potential yield of different varieties of fish not revalidated in recent years.
3. Optimum fleet size to sustain maximum yield not quantified.
4. Except the skipjack tuna, the other varieties of tunas, sharks, perches etc. are under exploited.
5. Fishery is restricted mostly to pole & line fishing. Diversified fishing is not prevalent.
6. Modernization of fishing craft & gear has not been attempted so far.
7. Infrastructural facilities such as boat jetties, workshops and mobile workshops are not adequate.
8. There are inter- Island conflicts and fishermen from one Island do not permit other Islanders to fish in their waters.
9. Fishermen not receiving IDs, permission to go beyond 12 nautical miles in the ocean to catch fish, sufficient credit, timely supply of fuel and spare parts.
10. Younger generation averse to fishing, leading to number of idle boats and reduction in the number of fishing boats.

3.1.2. Fish preservation and processing

1. There is no scope for making ice from freshwater, as it is scarce in the islands. Other than the one at Agatti, there is no plant to produce ice from seawater.
2. Cold storages and tunnel freezers are limited in number. The existing ones are not functioning properly since spare parts and accessories have to be brought from the mainland.
3. A major portion of tuna is converted as *Masmin*. Value addition of the products is not adequate.
4. Quality of *Masmin* is poor. The quality has to be improved along with marketing support through cooperative effort to realize better price.

5. The only canning plant in Minicoy is old with outdated technology. It is struggling to survive.
6. No provision for use of tuna byproducts/waste including tuna eyeballs.
7. No stable demand for canned tunas even from Institutional (Government departments etc.) sources.

3.1.3. Marketing

1. Marketing the catch and realization of better returns for the catch are major constraints.
2. There is no proper fish marketing chain or market development agency.
3. Fishermen not getting enough value on their diversified fish catch (non- tuna species and yellowfin tuna)
4. Canning factory exclusively dependent on supplies of skipjack tuna from Minicoy Island.
5. High cost of tuna cans.
6. Lack of proper transport facilities (connectivity) between the mainland and the islands.
7. Discouraging the traders from the mainland and lack of export link.
8. No attempt to advertise the high quality of tuna and tuna products caught by means of environment-friendly and responsible manner from the oceanic waters.
9. Fresh and live fish transportation vessel/refrigerated vessels/ marketing better returns.

3.1.4. Mariculture

1. Inspite of good scope for developing mariculture of ornamental fish, groupers, snappers, lobsters, pearl oysters, sea cucumbers and seaweeds, there is no mariculture activity. Infrastructure and policy for mariculture needs to be developed.
2. The island population is not aware of the available mariculture technologies and the benefits of mariculture.

3.1.5 Policy

1. The Department of Fisheries (DOF) is not effective in promoting and sustaining fisheries development.
2. Lack of a single window agency (Fisheries Development Agency) for assisting/promoting entrepreneurs to obtain all necessary licenses, permits, clearance etc.
3. Inadequate credit linked private investment in capture fisheries.
4. Several programmes suggested under Marine Fisheries Policy 2004 could not be implemented since government-controlled agencies alone could not take up those programmes.
5. Research, training, extension and human resource development are lacking in the fisheries sector.
6. Monitoring, control and surveillance by the DOF, Lakshadweep Marine Force and Coast Guard are not effective.
7. Recent technologies such as remote sensing, GIS, Satellite assisted vessel monitoring system have not been used for fish finding as well as to ensure the safety of the fishermen and the craft.
8. Considering the importance of the fisheries sector to the development of Lakshadweep Islands, the outlay of Rs. 28 crores under the X Plan is inadequate. Of the Rs. 28 crores, Rs. 18 crores is allotted for the introduction of mother vessel and only Rs. 10 crores is allotted for all other fisheries development activities for a 5-year period.
9. The X Plan proposal has ignored mariculture.
10. The plan does not envisage conservation of coral reefs, restoration of ecosystems and ecotourism.

3.2. Critical factors

1. Access to market
2. Poor connectivity to mainland
3. Inadequate processing capacity
4. Lack of value addition
5. Limitations of fishing crafts
6. Diesel subsidy
7. Conflicts between users of water bodies.
8. Inadequate power, water, credit, communications

4. CAPTURE FISHERIES

4.1. Assessment of resources

There is no proper stock assessment of fishery resources. Since the planning should be based on resource availability, there is immediate need for assessment of the resources and revalidation of the existing assessments by considering the pelagic as well as demersal resources.

Any fisheries development plan should essentially depend upon the yield and the potential yield. If the fishery is in pre-developed phase, it has to be promoted; resources should be identified; economic incentives should be provided; suitable craft, gear and equipments should be developed; and the fishermen should be trained. If the fishery is in developed phase it has to be maintained; and future prospects of stocks should be given priority. If the fishery is in an overexploited phase, attempts should be made to recover the fishery by investigating the causes; decide the levels of restrictions and enforcement; initiate stock enhancement programmes; and open alternate employment opportunities to the fishermen. It is also possible that fish stocks are in different stages of development, and hence, the stocks have to be categorized depending upon the status of exploitation. In this case, focus should be on investments in the types of craft, gear and equipment best suited for exploiting the identified stocks and processing them into products of demand. Hence, it is important that estimates on the potential yield and yield should be accurate.

4.2.Present Status

According to different sources, the estimated potential yield of tunas ranged from 50,000 tonnes to 90,000 tonnes. An examination of the estimates on the landings and potential yield of the Lakshadweep seas indicates the following shortcomings:

i. The frequency and coverage of fish landing observations are inadequate.

ii. Several boats from the mainland, especially from Cochin and Calicut operate in the Lakshadweep Seas and land the catch in the mainland. This catch is not accounted for in the yield estimates of Lakshadweep Islands.

iii. The potential yield estimates are based on the estimates on the landings. Hence, the potential yield estimates will be erroneous if the estimates on the landings are not precise.

iv. Reef fishes such as the groupers, snappers, breams and carangids, large pelagics such as the seerfishes, sharks and billfishes; small pelagics such as the scads; and the spiny lobsters are under exploited at present. Since these groups are landed in small quantities, it is likely that the potential yield is underestimated.

Considering this, it could be concluded that, the estimations on potential yield and landings are not accurate. Hence the mechanism of fish landings data collection should be improved and the potential yield estimates need to be revalidated. The landings should be estimated by following Stratified Multistage Random Sampling method. In this method, the landings in all the islands may be covered by giving weightage to the centers where the landings is good. Lakshadweep Administration may request the CMFRI to develop the scheme, evolve the methodology and train the officials of the Department of Fisheries for implementing the programme. The fish landing data collection should be strengthened by increasing the manpower and frequency of observation. If needed, arrangement may be made with CMFRI to analyse and interpret the data.

Fishery potential of Lakshadweep Islands has not been assessed in recent years. There is no dependable estimate of maximum sustainable level of exploitation, and this needs to be assessed for each commercially important variety. This information is vital for exploitation as well as for conservation of resources. The Administration may request the CMFRI and FSI to estimate the potential yield of commercially important varieties of finfishes and shellfishes.

4.3.Potential yield estimates

Considering the need for potential yield estimates, but the non-availability of dependable potential yield estimates for the Lakshadweep waters, the potential yield of major fish groups has been tentatively estimated in this document based on the landings in

the Lakshadweep islands and the resource surveys and potential yield estimates of fishery resources in the EEZ around Andaman and Nicobar Islands by Fishery Survey of India (FSI, 2005). The method of estimation of fishery resource potential in the Lakshadweep waters and the result obtained are given below:

Potential yield of A&N Islands	=	1,48,000 t (FSI, 2005)
Area of A&N	=	6,00,000 km^2
Potential yield of A&N/unit area	=	0.25 t/km^2
EEZ area of Lakshadweep	=	4,00,000 km^2
Potential yield of Lakshadweep	=	4,00,000 x 0.25 = 1,00,000 t
Potential yield of Lakshadweep	=	**1,00,000 t**
Potential yield of tunas	=	**50,000 t**

∴ Other resources = 1,00,000 – 50,000 = 50,000 t

Landings of fishes other than tunas

Major Groups	Avg. Production(t) (1975-85)	%	Potential Yield (tonnes)
1. Sharks	279	26.0	13,160
2. Perches	216	21.0	10,189
3. Belonids (gar fish) & Hemirhamphus	77	7.0	3,632
4. Seer fish	55	5.0	2,594
5. Carangids	43	4.0	2,028
6. Barracudas	13	1.0	613
7. Cephalopods	18	2.0	849
8. Red mullets	28	3.0	1,322
9. Flying fish	23	2.0	1,085
10. Others	308	29.0	14,528
Total	1060		**50,000**

4.4. Approach Analysis

It is suggested to increase fish production in the following ways:

i) Upgradation of existing fishing craft
- upgradation of traditional craft
- upgradation of pole & line fishing
- upgradation of gillnetter-cum-troll lines

ii) Introduction of new craft

- Tuna longline-cum-gillnetter for Sashmi grade tuna
- Maldivian type pole and line craft
- Mother/Collector vessels

iii) Modernization of fishing gear

iv) Improving the communication network

v) Installation of FAD's

4.4.1. Upgradation of existing crafts:

Upgradation of existing craft is suggested in order to increase the life of the boat, number of fishing operations in a year, efficiency of the boat and fish catch.

Wooden Pole and Line fishing boats

These wooden boats have live bait tanks and pole and line platform. The boat is fitted with an inboard engine. To upgrade the boats the following facilities are suggested:

i. FRP lamination for underwater hull

The underwater hull of these vessels is to be coated with FRP laminations with two layers of CSM 300 glass mat using Isopthalic resin. This is to protect the underwater hull from fouling and increase the life of boat.

Approximate cost : Rs.35,000/- per boat

ii. Providing live bait tanks

These crafts are to be provided with live bait tanks made of FRP. To make the bait tanks light, long lasting and maintenance free, these can be made in FRP.

Approximate cost : Rs 20,000/-

iii. Providing a sprayer in the boat

Cost of this item : Rs 20,000/-

iv. Insulated Fish box

An insulated FRP Fish box could be introduced in the vessels. The FRP lay up to be

provided for this item is two layers of CSM 300 in the outer layer, two layers of CSM 300 in the inner layer and polyurethene foam (PUF) to be filled up as the filler in the space between the inner and outer layer gap of 25mm. PUF slab should not be used. Only PUF chemical to be poured into the gap.

Approximate cost : Rs: 25,000/-

v. Solar panel

Solar panels can be provided to give lighting and horn for these boats.
Approximate cost : Rs: 7,000/-

vi. Life jackets and life buoys

In all the existing boats, life jackets and life buoys can be provided.

Approximate cost for 4 life jackets and one life buoy: Rs 15,000/-

The constraints in the above activities

Well experienced FRP contractors / workers are to be pooled from the main land for this job. Only Isopthalic resin should be used for the FRP work on fishing boats. Space availability inside the boat may be a constraint to provide the insulated FRP fish box.

The Directorate of Fisheries has acquired four wooden long line boats. These boats shall be upgraded with the following facilities:

1. Providing a Long Line Hauler driven by the main engine of the boat. A line hauler is to be fitted on these boats. A line hauler with brake and tension generating pulleys are to be provided.

Approximate cost for this item : Rs: 50,000/-

2. An insulated fish box to be provided. Apprx. Cost : Rs: 25,000/-

3. A solar panel. Apprx. Cost : Rs: 7,000/-

Details on the economics of upgradation and introduction of new crafts are given in Section 5.

4.4.2.Introduction of modern vessels

Longliner cum Gillnetter

The large *thonis* (6 and 8 men) can be used for operation of large meshed gillnets (100-180mm) for the capture of large tunas (yellowfin), seerfishes, half-beaks, dolphinfishes, sharks etc. At present many innovative fishermen of Androth Island are employing gillnets of smaller dimension. This method of fishing should be promoted in other islands also. This can land an addition of nearly 4500t of very high value fishes at reduced fuel consumption.

It is suggested to introduce tuna long liners with deep freezing and cold storage facilities in the Lakshadweep waters. Hydraulic long line hauler with line storage on deck is suggested.

The brief technical specifications are given below:

Length Over All	:25 to 30 m
Breadth	: 7 to 9 m
Depth	: 3 to 4 m
Main engine	: 600 to 700 H.P
Freezer	: At - 60 ^{O}C 300 kg/h
Fish hold capacity	:30 tonnes at - 60 ^{O}C for Sashimi grade tuna
Speed	:10 to 12 knots
Bait tanks	: 10 m^3
Hydraulic line hauling	: To haul 125 km long, 3.5 mm dia, fitted with 2000 hooks

The spool, line setter, speed read out, timer, hauling block etc. to be given for operating speed ranging from 0 to 10 m per seconds.

Crew	: 21 persons
Equipments	: All modern navigation and fish finding equipments to be installed on board.

Approximate cost of one vessel is : Rs 500 lakhs

Mother/Collector Vessel

The proposed mother vessel is a multi-purpose vessel used for fishing as well as collection of fish from smaller fishing crafts and store on board after possessing. This will have carrying capacity of about 70-100 tonnes and have facilities like plate freezers, blast freezers, cold storages, etc, for processing the fish and keeping the same in fresh condition for a longer period. A mother vessel can take a good number of smaller fishing boats along with it to far away fishing grounds where there is no land to halt for about 10-15 days. They will fish during this period with smaller boats. The smaller boats will conduct fishing and deliver the catch to the mother vessel for processing and storing. The accompanying smaller boats can receive provisions like diesel, fresh water, etc. from mother vessel thereby the operational cost of smaller boat will also drastically come down. Fishing grounds located near the submerged reefs like Cheriyapani, Valiyapani, Perumalpar and Azhikalpeni, etc where no land or land based infrastructural facilities are available. The mother vessel also can carry fresh fish to mainland for marketing/export.

Two collectors cum carrier vessels are to be introduced in the Lakshadweep waters to collect the fish from small boats operating around the islands.

The brief technical specifications are given below:

Length Over All	: 30 to 35 m
Breadth	: 8 to 10 m
Depth	: 3.5 to5 m
Main engine	: 600 to 700 H.P
Freezer	: At - 60 ^{O}C 300 Kg/Hr
Fish hold capacity	: 30 to 40 tonnes at - 60 ^{O}C for *Sashimi* grade tuna
Speed	: 10 to 12 knots
Crew	: 12 persons
Equipments	: All modern navigation equipments to be installed on board.
Cost	: Approximate cost is Rs. 800 lakhs

Pole and line boat with wooden deck (Larger Vessels)

Based on the Maldivian experience, it is suggested to introduce 15-16 m long boats with 120 hp engine. These boats will have 6 to 7 days endurance. The cost of each boat alongwith gear is Rs. 30.00 lakhs.

Maintenance and Bunkering

Sufficient facilities for berthing of the vessels are to be provided. Annual docking and other maintenance of the vessels are to be arranged at mainland.

4.4.3.Fishing gear

Inadequate supply of poles, strength and durability of bamboo poles, shortage of live bait fish, far away and scattered fishing grounds, high and increasing cost of fuel, are some the major constraints in live bait pole and line fishing method. More fishermen are required for operating pole and line fishing as compared to gill net operations. It is suggested that gillnets and handlines may be operated from the existing vessels. The approximate cost of gill nets required for operations from the existing fishing vessels would be around Rs. 2 lakhs, which would include the webbing, floats, sinkers, rigging charges and spare set of net and accessories. The approximate cost of mono lines along with hooks, and other accessories would cost around Rs. 2.5 lakhs per vessel. The approximate cost of hand lines with hooks and sinkers and hand reels per vessel would be Rs. 50,000 per vessel. The approximate cost of each lobster, fish and crab traps are Rs. 4,000, Rs. 3,000 and Rs. 2,000 respectively (Table 7).

Table 7. The cost of various fishing gears required for operation from the existing fishing vessels

Sl No.	Fishing gear per boat	Approximate cost (Rs.)
1.	PA Gill nets (1500 m) with accessories	2.0 lakhs
2.	PA Monolines with 500 hooks and accessories	2.5 lakhs
3.	Handlines with hooks and reels	0.5 lakhs
4.	10 Lobster traps @ Rs. 4000	0.4 lakhs
5.	10 Fish traps @ Rs. 3000	0.3 lakhs
6.	20 Crab traps @ Rs. 2000	0.4 lakhs
7.	20 Octopus traps @ Rs. 2000	0.4 lakhs
8.	20 Ornamental fish traps @ 1000	0.2 lakhs

Pole and line fishing

- Pole and line fishing being the main fishing method in the islands, this fishing method can continue with further improvements. The existing bamboo poles can be fabricated with FRP at Lakshadweep itself. The FRP poles will be lighter, stronger and maintenance free and would last longer.
- Good aerated bait tanks in all the fishing vessel will have to be provided for increasing the life of the live baits in the tanks.
- Mechanical spraying of seawater in the aft portion of the boat will have to be provided in all the pole and line fishing boats to enhance the chumming action to increase the catch.

Gill nets

Large mesh drift gillnets for pelagic fish

- Large mesh (100-160 mm) nylon multifilament gillnets can be operated for pelagics like the sailfish, barracudas, seerfish, marlin, swordfish, yellowfin tuna and skipjack tuna. As these resources are abundant and are not fully exploited, the diversified fishing method would pave the way for exploitation of these resources in a profitable manner.

The existing fishing vessels of Lakshadweep islands can be used to operate gill nets with minor modifications for targeting pelagic fishes. This fishing method is energy saving

due to the proximity of fishing grounds from the shore unlike in the case of pole and line fishing where they have to steam for hours in search of fish schools. The manpower required would be much less, 4 persons in case of gill net operations as against 7 –9 persons for pole and line fishing operations.

Lines

Monolines for tunas and other large pelagics can be introduced in the wooden vessels available with the Dept. of Fisheries, Lakshadweep. Minor modifications on the deck of the vessel may have to be carried out for smooth operation of the lines. An appropriate line hauler will have to be fabricated and fixed on board the fishing vessel. Nearby tuna fishing grounds will have to be located and arrangements for appropriate baits will have to be made for successful fishing operations for tuna long lines. The vessel will require fish storage facility and should be equipped with navigational and communication equipments for long trips of at least one week. Approximately 500 hooks will have to be operated in one day.

Monolines can be operated from the existing fishing vessels with minor modifications for facilitating operations of lines. The lines can be hauled up by hand. Ice storage facilities will have to be provided as the fishing grounds are most likely to be far away from the shore. The target fishes would be yellowfin tunas, marlin, sailfish, sharks, dolphin fish and other pelagics.

Hand lines are being practiced by the fishermen in and around the lagoons and also outside the lagoons in the rocky areas for coral reef fishes. The hook size ranges between 5 and 8. Meat or gut of tuna or pieces of octopus is used as bait. Fishing is mostly during night. Appropriate size and shape of hooks should be used for each target species. Drop lines with multi hooks can be used in deeper waters, which would increase the catching efficiency. Fishing reels can be installed around the sides of the vessel so that the hauling process can be faster and there will not be entanglement of the lines.

There are good resources of bottom fishes in the rocky and coral areas of the islands. Vertical drop lines with multi hooks can be operated for increasing the catch. Handlines using monofilament lines of different diameters and different hook sizes can be used for targeting the bottom dwelling reef fishes. Provision for few hand line reels to haul up the lines more quickly can be provided in the side of the deck for easy operation and hauling of the lines. Suitable baits like meat of octopus, viscera of tuna can be used.

Trolling is being practiced by few islanders targeting tunas, seerfish, barracudas and other fast moving pelagics. At present the lines are operated by tying the line at the aft portion of the fishing vessel. The system can be improved by providing booms on both sides for facilitating operation of more number of troll lines. Artificial baits presently used by the fishermen can be used for the troll line operation.

There is good scope for improving the troll line fishing techniques by adding booms and having additional lines attached to the booms. These can also be operated while steaming from the island to the fishing ground and back as well as in the regions where FADs are installed.

Traps

The lagoon fishes and octopus are harpooned and caught by the islanders. They dive and search in the crevices and take out the octopus by piercing it with a sharp object. There is good scope of operation of traps in the lagoon and reef areas of the island to capture the reef fishes, octopus and lobsters. However, fishing with traps in the coral belt areas will have to be carried out with caution. The advantage of trap operation is that the fishes and lobsters can be caught live and the possibilities of live fish export can be ventured. The juveniles or the young ones caught by the traps promises scope for fattening and marketing.

Traps for lobsters

- There are good resources of lobsters in and around the islands. Suitable baits will be required for successful operation of lobster traps.

Traps for bottom fishes

- Collapsible fish traps can be operated in the reef areas for fishes. It also can be taken by boat for operation in the deeper areas.

Traps for Octopus

- Traps for octopus can be designed and developed for harvesting octopus.

Traps for ornamental fishes

- There are good resources of ornamental fishes in and around the islands. Suitable traps are to be introduced. Training should be imparted for careful operation of these traps among the coral reefs so as not to destroy / disturb the ecosystem.

Training programme can be conducted in the fabrication, rigging and practical training in diversified fishing practices for the benefit of the fishermen.

4.4.4. Establishment of a fisheries communication network

At present the pole and line-fishing boats spend considerable time in scouting and searching for tuna shoals. This seriously affects the profitability of the boats, besides resulting in waste of valuable energy in terms of diesel and manpower. It is well known that the biting frenzy of tuna shoals are at a peak during early morning and evening hours, and therefore, for increased efficiency of the P & L units, it is necessary that the boats arrive at the grounds during this time. Shoals located at other times do not display the same feeding frenzy and are not of same magnitude. The Islands already have a marine communication network (VHF) for ship to ship and ship to land communications. This facility is available in all the inhabited islands and is under the control of the port department and is locally known as control towers.

If the P &L units are equipped with VHF and GPS, prior information on shoal availability and abundance can be communicated to the fishing boats using this facility. Since P&L fishing is mostly done by groups of boats, this communication facility can be provided to one of every four boats as an incentive by the DoF. The quick dissemination of the information gathered on the shoal movements from different grounds can yield higher

catch rates and would reduce the scouting time and fuel consumption. Furthermore, the existing information on PFZ provided by the NRSA can also be communicated using this network.

4.4.5. Installation and monitoring of FADs

Introduction/deployment of FADs are helpful in the augmentation of fish catch particularly of the migratory pelagic fishes like tunas. There is no evidence to suggest that the FADs increase the overall number of tunas in a given area. Rather, they attract and gather fishes from a larger area to a smaller one and make them easier to locate and catch. As a result the catches and catch rates tend to be higher. Also, the FADs help to reduce the scouting time and fuel consumption. However, the negative aspect of FADs is that the young ones of tunas, especially of the yellowfin are attracted more, resulting in higher catch of juveniles in the FAD sites (18-20%) than in the non-FAD sites (4-5 %) This may affect the stocks and the future catches if not managed properly.

At present, two National Institute of Ocean Technology (NIOT) data buoys off Minicoy and Pitti are acting as FADs. Lakshadweep Administration is being deployed 30 FADs with the help of NIOT, Chennai.

Surface FADs: The surface FADs deployed on the eastern side of the islands (to enable access during monsoon) at 2-4 nautical miles from the coast may be utilized for promoting ecotourism such as for fish/dolphin watching and sport fishing.

The following points should be considered while deploying and utilizing the FADs:

1. Gillnetting to be prohibited/banned within 2-3 nautical miles radius of the FADs.

2. One each at Agatti; Kavaratti, Minicoy, Kalpeni, Kadmatt and Bangaram to be reserved for trolling, fish watching, sport fishing and for the promotion of the eco-tourism.

3. The boats should be advised not to go very closer to the FADs and should avoid mooring to the structures.

4. The fishermen should be cautioned about the long-term sustainability issues catching the undersized (juveniles & young ones) fish, which tend to aggregate in considerable numbers during certain months.

5. ECONOMIC EVALUATION OF CAPTURE FISHERIES- CURRENT AND PROJECTED SCENARIO

The conventional economic theory envisages economic development as an auto centric force, certain to appear in any society when appropriate ingredients like capital, technology and similar inputs are supplied. The inner dynamics applied for such linear economic growth and transformations were not restricted to mere surplus augmentation over time but it needs interlinking of inner sectors by forward and backward linkages. However in the comparatively closed economies like Lakshadweep, what really matter in the development endeavour are not only capital and technology, but also the socio economic milieu within the ambit of which these catalysts interact. The improvement in socio economic welfare and livelihood options of the islanders are the ultimate yardsticks to measure the success of the development agenda.

The livelihood of Lakshadweep Islanders is almost entirely dependant on fisheries and coconuts. Total population inhabited in the islands comes about 60,595 during 2001. There is very high literacy rate of 82.6% percent. The density of population is in the order of 1894 persons per square kilometer inspite of the scarcity of land and potable water. Currently there are about 7828 fishermen engaged in active fishing in Lakshadweep as against 5550 in 1992-93 showing a growth rate of 41 % as against population growth rate of 17 %. The economic growth of the islands is possible only by promoting employment opportunities which can be attained through enhancing production from capture fisheries around the islands with forward linkage of appropriate market avenues.

5.1 Upgradation of existing craft

Increasing the present yield using existing facilities and infrastructure

This approach envisages increasing the yield by exploitation of hitherto unexploited fishing grounds and resources. The tunas have the tendency to aggregate near *paar* areas, sea mounts and banks. For example, the Perumul Paar, Veliyapaaniyam, Cheriyapaaniyam, Elikalpeni Bank, Investigator Bank, Suheli Paar etc. are rich in tuna resources, but are not

fully utilized for the exploitation of tunas and reef fishes (rock cods, snappers, carangids, wahoo, sharks etc.).

For exploiting these resources, the existing 8 DoF vessels are suggested to function as dory (mother) vessels, which will tow the traditional non-motorized and motorized *thonis* (1 dory unit will tow 5 *thonis*) to these *paars* from Agatti, Bitra, Kiltan, Chetlat, Minicoy and Androth. These vessels will conduct 2 to 3 days of fishing. The dory vessels will carry sufficient ice for storage of fishes caught by *thonis*. The method of fishing employed will be gill-netting, trolling, hand-lines, traps and small long-lines that the *thonis* usually carry. Such a system would provide increased job opportunities (180 jobs-assuming 20 persons in a dory unit) and catch to the tune of 700 tonnes per year.

Many pole and line fishing vessels, especially in Agatti are idling due to shortage of manpower. Off Minicoy, the use of mechanical water sprayers in the place of fishing hands has reduced the number of fishers required for each vessel from 9 to 7. These two excess fishers can be used to man the idling boats (steppney boats), thus increasing the number of boats in operation and catch by 15%.

Current production around the seas of the island is about 10 % of the potential yield. Hence the development agenda engendering employment opportunities by optimising fish production ought to have multiplier and accelerator impact on the standard of living of the dependent population. With adequate marketing support and linkages there is good scope to increase production by up gradation of existing fishing units. In the Ist phase of 2006-10, it is suggested to upgrade the existing traditional fishing units, pole & line fishing units and Gillnetter cum troll line. The Indicative comparative economics of these units are given in Table 8,9 & 10.

The upgradation of traditional boats involves repairing and coating of underwater hull with FRP lamination. Currently, there are about 150 traditional fishing units operating in Lakshadweep islands with annual gross production of about 500 tonnes realising Rs 75 lakh as gross revenue. The proposal of upgrading 40 units being towed by 8 Department of Fisheries vessels alone may fetch a catch of 700 tonnes with potential of realising gross revenue of Rs. 175 lakh in the same price level generating gross additional revenue of Rs

100 lakh. This may not only provide additional employment opportunity, but also enhance the annual per capita earnings of fishing labourer from about Rs 10,000 to Rs 50,000/. The indicative unit economics of these two types of operations is given in Table 8.

Table 8. Indicative Economics of Traditional Fishing Units in Lakshadweep (Annual/unit)

SL.NO	ITEM	EXISTING units	UPGRADED units
1	**Average Capital Investment (Rs)**		
a	Country Craft (Resale Value)	25,000	50000
b	OBM	40,000	40000
c	Gear & Others	3,000	15000
d	Towing Boat (20 %)	-	60000
	Total	68,000	1,65,000
2	**Annual Fixed Cost (Rs)**		
a	Craft @ 10 % & 5% depreciation for towing boat	2,500	8000
b	OBM @ 10 % depreciation	4,000	4000
c	Gear @ 50 % depreciation	1,500	7500
d	Interest 10 %	6,800	16500
	Total Fixed Cost	14,800	36000
3	**Operating cost (Rs)**		
a	Fuel cost (including towing cost)	20,000	20000
b	Labour cost	41,690	2,18,750
c	Other costs	3,000	5000.00
	Total Operating Cost	64,690	2,43,750
4	**Total Cost (Rs)**	79,490	2,79,750
5	**Catch & Revenue**		
a	Catch (Kg)	3,335	17500
b	Average price/kg **(Rs)**	25	25
c	Gross revenue **(Rs)**	83,375	4,37,500
5	**Net Operating Income (GR-OC) (Rs)**	18,685	1,93,750
6	**Net Profit (GR-TC) (Rs)**	3,885	1,57,750

If all the 150 units are brought under this system of operation, the gross production would be 2625 tonnes generating gross revenue of Rs 656.25 lakh. The additional boats required for towing is 22, costing about Rs (22 x 3 lakh) 66 lakh additional investment.

Pole and line units need upgradation for increasing their fishing trips and catch rates. The number of annual fishing trips in the upgraded units is expected to increase from 184 to 275. The catch per unit per trip in the proposed plan may increase from 23 tonnes to 35 tonnes. With increasing fishing trips, the upgradation may yield an additional catch of 3600 tonnes per annum generating gross revenue of Rs 875 lakh. The unit economics of existing units indicate a net profit of only Rs 46800 per annum as against Rs 1, 08,400 for the proposed upgraded pole & line units (Table 9).

Table 9. Indicative Economics of Pole and Line Units in Lakshadweep (Annual)

SL.NO	ITEM	EXISTING UNITS	UPGRADED UNITS
1	**No. of Fishing trips**	184	275
2	**Capital Investment (Rs)**		
a	Hull (28' to 32')	1,25,000	1,75,000
b	Engine	1,20,000	1,30,000
c	Gears	10,000	10,000
d	FRP coating	~	35,000
e	G.P.S	~	12,000
f	Sprayer	~	20,000
g	VHF communication	~	25,000
h	Safety equipments	~	15,000
i	Others	5,000	5,000
j	Total	2,60,000	4,27,000
3	**Annual Fixed Cost (Rs)**		
a	Depreciation (20 % for boats)	52,000	85,400
b	Interest (10 %)	26,000	42,700
	Total Fixed Cost	78,000	1,28,100
4	**Operating cost (Rs)**		
a	Fuel cost	1,47,400	1,90,000
b	Labour cost	2,33,500	4,37,500
c	Repair & maintenance	5,000	6,000
d	Miscellaneous	3,000	5,000
	Total Operating Cost	3,88,900	6,38,500
5	**Total Cost (Rs)**	4,66,900	7,66,600
6	**Catch & Revenue**		
a	Catch in tonnes	23	35
b	Price Rs/Kg	22	25
c	Gross Revenue **(Rs)**	5,13,700	8,75,000
7	**Net Operating Income (GR-OC) (Rs)**	9,02,600	2,36,500
8	**Net Profit (GR-TC) (Rs)**	46,800	1,08,400

The gross catch of the 300 existing units is about 6900 tonnes fetching annual revenue of Rs 1518 lakh. The upgraded units are expected to catch 10,500 tonnes with a gross value of 2625 lakh per annum. The additional capital investment for this upgradation will be Rs 546 lakh.

Gillnetter cum troll lines needs to be upgraded with an additional investment of Rs 1.4 lakh per unit (Table 10). The capital investment needed for all 100 units will be Rs 140 lakh. The expected catch per unit for the upgraded units is 42 tonnes per annum as against the current catch rate of 30 tonnes per annum. The increase in gross production will be 1200 tonnes fetching an annual additional income of Rs 3600 lakh. The expected annual production from these units will be 4200 tonnes.

Table 10. Indicative Economics of existing and upgraded Gillnetter cum Troll Lines units in Lakshadweep (Annual)

SL NO	ITEM	EXISTING	PROPOSED UPGRADED UNITS
1	**No. of Fishing trips**	200	280
2	No of crew	4	4
3	**Capital Investment (Rs)**		
a	Hull (28' to 32')	1,25000	175000
b	Engine	120000	130000
c	Gears	15000	15000
d	FRP coating	~	35000
e	G.P.S	~	12000
f	VHF communication	~	25000
g	Safety equipments	~	8000
h	Others	5000	5000
	Total	2,65,000	4,05,000
4	**Annual Fixed Cost (Rs)**		
a	Depreciation (20 %)	53000	81,000
b	Interest (10 %)	26500	40,500
	Total Fixed Cost	79500	1,21,500
5	**Operating cost (Rs)**		
a	Fuel cost	80000	84000
b	Labour cost	375000	630000
c	Repair & maintenance	10000	20000
d	Miscellaneous	5000	5000
	Total Operating Cost	470000	7,39,000
6	**Total Cost (Rs)**	549500	8,60,500

7	**Catch & Revenue**		
a	Catch (tonnes)	30	42
b	Price Rs/Kg	25	30
7	Gross Revenue **(Rs)**	750000	12,60,000
8	**Net Operating Income (GR-OC) (Rs)**	280000	5,21,000
9	**Net Profit (GR-TC) (Rs)**	200500	3,99,500

Table 11. Indicative Economics of new Pole & line units and Gillnetter cum troll lines

SL NO	ITEM	POLE AND LINE UNITS	GILLNETTER CUM TROLL LINES UNITS
1	**No. of Fishing trips**	275	280
A	No of crew		4
2	**Capital Investment (Rs)**		
A	Hull (28' to 32')	250000	250000
B	Engine	240000	240000
C	Gears	10000	15000
D	FRP coating	35000	35000
E	G.P.S	12000	12000
F	Sprayer	20000	
G	VHF communication	25000	25000
H	Safety equipments	15000	8000
I	Others	5000	5000
	Total	612000	590000
3	**Annual Fixed Cost (Rs)**		
A	Depreciation 10% for new boats	61200	59000
B	Interest (10 %)	61200	59000
	Total Fixed Cost	122400	118000
4	**Operating cost (Rs)**		
A	Fuel cost	190000	84000
B	Labour cost	450000	645000
C	Repair & maintenance	6000	20000
D	Miscellaneous	5000	5000
	Total Operating Cost	651000	75400
5	**Total Cost (Rs)**	773400	872000

6	**Catch & Revenue**		
A	Catch in tonnes	36	43
B	Price Rs/Kg	25	30
7	Gross Revenue **(Rs)**	900000	1290000
8	**Net Operating Income (GR-OC) (Rs)**	249000	536000
9	**Net Profit (GR-TC) (Rs)**	126600	418000

5.2. Introduction of new vessels

It is suggested to introduce 100 pole and line units and 50 Gillnetter/troll lines during the second phase. The required initial investment will be Rs 612 lakh for pole and lines and Rs 295 lakh for Gillnetter/troll lines (Table 11). The annual gross catch generated from these units is expected to be 5750 tonnes.

It is proposed to introduce 3 Tuna Long Liners cum Gillnetter in the II nd phase (1 each based at Minicoy, Kalpeni/Androth and Agathi), which can be increased to 10 numbers in the III rd phase. The projected economics of these units is given in Table 12.

The estimated capital requirement for introducing these units is Rs 2250 lakh in the II nd phase and Rs 5250 lakh in the III rd phase. The projected annual catch from these units will be about 600 tonnes of Sashimi grade tuna in the II nd phase and 3000 tonnes in the III rd phase.

Table 12: Projected Cost & Earnings of Tuna Longliner cum Gillnetter for Sashimi Grade at – 60 ° C (12 crew, 10 voyage/annum, 20 days /voyage)/ 10 voyage)

SL NO	Items	Rs. in lakh
1	**Capital Investment (OAL- 25 to 30 m)**	
a	Hull	150
b	Main engine, generator, auxiliary engine	300
c	Equipments	120
d	Gears(long liner, 2000 hooks, gillnet 500 m)	30
e	Others(Specify)	150
	Subtotal	750

2	**Annual fixed Cost**	
a	*Depreciation*	
b	Hull @ 5 %	7.5
c	Main engine, generator, auxiliary engine @ 10 %	30
d	Equipments @ 10 %	12
e	Gears(long liner, 200 hooks, gillnet 500 m) @ 5 %	15
f	Others @ 10 %	15
g	Subtotal	79.5
h	*Interest @ 10 % per annum*	75
i	Subtotal (depreciation +Interest)	154.5
3	**Operational Cost**	
a	Wages	
	a. Skipper	4.8
	b. Chief Engineer	4.2
	c. Mate	3
	d. Engineer	3
	e. Oil Man	1.8
	f. Deck crew	9.6
	g. Others	4.8
b	Fuel(35000 ltr/voyage@Rs35/) Includes cost of freezing and cold storage (12.50 *10)	122.5
c	Food/Bata (Rs.50/person X 20 days X 20 persons	2
d	Baits(10000 nos)	4
e	Repair and Maintenance	10
f	Handling/ Repacking and Marketing	10
g	Others (Specify, if any)	20
	Subtotal	199.7
4	**Total Cost**	354.2
5	***Catch***	
a	Tuna 15 tonnes/voyage	150
b	Shark 3 tonnes/voyage	30
c	Others 12 tonnes/voyage	120
d	Subtotal	300
6	***Revenue***	
a	Tuna (50 %) (Rs 250/Kg)	375
b	Shark (10 %) (Rs 60/Kg)	18
c	Others (40 %) (Rs 30/Kg)	36
d	Subtotal	429
7	**Total Revenue (Rs)**	429
8	**Net Profit (Rs)**	74.8
9	**Pay Back Period (Years)**	5.01
10	**Rate of Return (%)**	20
11	**Average Price Realised (Rs/Kg)**	143
12	**Break Even Price(Rs/Kg)**	118
13	**Break Even Production (Tonnes)**	248

The proposal suggests the introduction of 50 Maldivian type wooden deck pole and line units in the II nd phase and another 50 units in the III rd phase, the total investment being Rs. 3000 lakh in the II nd & III rd phases. The annual gross production generated from these units will be about 18,000 tonnes in the second phase and 36,000 tonnes in the third phase (Table 13).

Table 13: Projected Costs and Earnings of Wooden Deck Poll & Line Maldivian type Boats Crew 12-15 with 60 trips of 3 days duration)

SLNO	ITEMS	Rs. in Lakhs
1	**Capital Investment (OAL-15-16 m)**	
a	Hull (Life 15 years)	14
b	Engine (120 HP- single, in -board) (Life-5 years) & others	9
c	Gears (Life 2 years)	7
d	Total	30
2	**Annual Fixed Cost**	
a	Depreciation	
b	Hull (Life 15 years)	0.98
c	Engine (16-20 HP- single, in board) (Life 5 years) (20 %)	1.80
d	Others (Specify)(Propeller, shaft, life jacket, life buoys etc(25%)	1.75
e	Sub total	4.53
f	Interest (10%)	3.00
g	Sub total (depreciation+ interest)	7.53
3	**Operational Cost (FOR 60 TRIPS)**	
a	wages	45.00
b	Fuel @ Rs 35 X 60	12.60
c	Ice(2000kg@1.5/kgX60	2.00
d	Repair and Maintenance	2.00
e	Others(Specify, if any)	5.00
f	Subtotal	66.60
4	**Total cost**	74.13
	Catch (t)	360
a	Average price of Tuna (Rs /Kg)	25
5	**Total Revenue (Rs)** (360 x 25)	90
6	**Net Profit (Rs)**	15.89
7	**Pay Back Period (Years)**	1.50
8	**Rate of Return (%)**	62.00
9	**Average Price Realised (Rs/Kg)**	25.00
10	**Break Even Price(Rs/Kg)**	21.00
11	**Break Even Production (Tonnes)**	296.52

In the I phase a mother/collector vessel may also be introduced for serving the other boats. The mother collector vessel indicated in Phase I will collect tunas and other fishes from around the islands. This vessel will be fully operational from Phase II onwards concentrating on collection, storage and transport of *sashimi* grade tunas. The indicative economics is giving a positive trend (Table 14). One more vessel may be added in the III rd phase depending on its utility.

Table 14: Indicative Economics of Mother/ Collector Vessels in Lakshadweep Waters (Annual)

SLNO	ITEM	CAPACITY (50 TONNES) Rs in Lakh
1	**Capital Investment (Life 15 years)**	800
2	**Annual Fixed Cost (7 %)**	56
3	No of days in Sea	200
4	**Operating Costs**	
a	Wages	
	1. Captain	7.0
	2. Skipper	4.8
	3. Chief Engineer	4.2
	4. Oil Man	3.6
	5. Mate	3.0
	6. Bosun	3.6
	7. Deck crew	7.5
	8. Others	7.5
	Fuel	70.0
	Total operating cost	111.2
5	**Total cost**	167.2
6	**Cost of Fish (Procurement)**	
a	I Grade	500
b	II Grade	450
c	Subtotal	1117.2
7	**Revenue**	
a	I Grade @300/Kg X 200t	600
b	II Grade @ 50/ Kg X 1300 t	650
c	Subtotal	1250
8	**Profit**	132.80

Location specific infrastructure development at various islands and strategically important locations in the mainland is essential for devising suitable supply linkages in an ever changing competitive market scenario. Supply of Lakshadweep branded fishery products in the mainland and the international markets should be attempted to achieve maximum benefit. When the products gain marketability the demand will create its own supply and increase the profitability of fishing operations. Higher profitability will enhance the induced investment and thereby immense possibilities to obtain optimum production from capture fisheries. The multiplier and accelerator effect on the production front will enhance the living standards of all stakeholders in Lakshadweep Island due to spread effect of spill over benefits.

6. BUILDING OF INFRASTRUCTURE FACILITIES FOR HANDLING, STORAGE, PROCESSING AND MARKETING

Annual fish production in Lakshadweep Islands is about 10,000 tonnes; tunas contribute 90% of which, local consumption as fresh fish and raw material for *masmin* production accounts for about 99% of the landing while a small quantity, less than 1% is utilized for canned tuna production. The development program for Lakshadweep Islands is planned to increase the annual fish production to 17,325 tonnes in the 1st phase, 41,675 tonnes in the 2nd phase and 62,075 tonnes in the 3rd phase respectively (Table 15). During the III Phase, it is envisaged that 62% of the potential yield will be harvested.

Table 15: Expected annual catch (tonnes) during the phases.

Type of fishing vessels	**I Phase** (2006-07 to 2009-10)	**II Phase** (2010-11 to 2012-13)	**III Phase** (2013-14 to 2016-17)
I. Upgradation			
1. Traditional	2625	2625	2625
2. Pole & Line	10,500	10,500	10,500
3. Gillnetter-cum-Troll line	4200	4200	4200
II. Introduction of new vessels			
1. Pole &Line	-	3600	3600
2. Gill netter	-	2150	2150
3. Longliner	-	600	3000
4. Maldivian	-	18000	36000
Total	17325	41675	62075

Based on the resource availability about 16 commercially important products have been identified and their production targets are presented in the Table- 16.

Table 16. Products identified and production targets

	Products	**1st phase (tonnes)**	**2nd phase (tonnes)**	**3rd phase (tonnes)**
1	Frozen whole & round tuna for export	1200	1600	2400
2	*Shashimi* Grade Tuna	-	1200	1600
3	Chilled, smoked and frozen tuna loins	-	350	700
4	Fresh tuna in chilled form for distribution in mainland	900	1350	1800
5	High quality *masmin*	250	250	500
6	Value added tuna product*		225	450
7	Frozen whole fish for export	340	565	900
8	Battered and breaded products for export*	120	200	320
9	Mince based value added products for export *	600	1000	1600
10	Salted and cured shark meat	225	375	600
11	Shark liver oil	15	25	40
12	Shark cartilage	22.5	37.5	60
13	Shark fin	7.5	12.5	20.0
14	Shark skin leather	3.75	6.25	10.0
15	Canned tuna (in oil and curry)*	18 lakhs (333 tonnes/yr)	28.80 lakhs (532.8 tonnes)/yr	36 lakhs (666 tonnes/yr)
16	Fish waste utilization & production of organic manure	2500	4000	6000

The items marked (*) indicate only a general classification while it includes a number of products in that category. Production and marketing of this product is likely to generate income to the order of Rs. 3000 lakhs, Rs. 7300 lakhs and Rs.13000 lakhs respectively in the first, second and third phases when implemented systematically. The existing fish processing facilities available in Lakshadweep Islands are shown in Table-17.

Table 17. Existing fish processing facilities available in Lakshadweep Islands

1.	Cold storage, 25 tonnes capacity	20 Nos.
2.	Cold storage, 15 tonnes capacity with chilled room facility	1 Minicoy
3.	Tunnel freezer, - 40°C, 3 tonne capacity	1 (Minicoy)
4.	Cold storage, 5 tonne capacity	5 Nos. 2 at Chethlath 1 each at Agathi, Kavarathi and Anthroth
5.	Tunnel freezer, 5tonne capacity	2 Nos. One at Agarthi and the other at Chethlath
6.	RSW plant, 2 ton capacity	2 Nos
7.	Walk in freezer, 3 tonne capacity	2 Nos.
8.	Ice plant, 1 tonne capacity	1 No. Agathi
9.	Canning plant, 1 500 cans/day	1 No. Minicoy
10.	Sea water ice plant 10 tonne capacity	2 Nos. at Kavarathy and Androth

Proposals for establishing seawater ice plants of 10 tonnes capacity in other islands have been already approved. During the 1st phase of the plan period the existing facilities may be strengthened/improved/renovated and attempts should be made for the full utilization of the installed capacity. The canning plant at Minicoy may be modernized with high speed seaming machine, bigger retorts, cookers and the plant capacity increased to 8,000 cans per day in Phase II which can be further increased to 10,000 cans /day in Phase III.

6.1. Fish processing facilities

The infrastructure facilities proposed in this document are necessary to meet the various tasks involved in the post harvest processing of fish. The third phase of the program expects the annual landings to be increased to about 62,000 tonnes including 1600 tonnes of *sashimi* grade tuna. This works out to about 100 tonnes of fish per day available for processing. Integrated fish processing plants comprising freezing, frozen storage, chill

storage, value addition units etc are proposed at three major fish producing islands. In addition to the ice plants already sanctioned, three more ice plants at the above centres are proposed for handling the increased fish landing. Commercially important fishes like tuna, reef cod, seer fish, cephalopods etc may be processed into frozen products making use of the freezing and cold storage facilities set up and may be sent to mainland for marketing domestic as well as export.

6.1.1. Value added fish products

A variety of fish products can be included in this category. Tuna based value added products, value added products from octopus mince based value added products such as fish cutlet and fish burger, fish pickle etc. are already established in the export market as well as metropolitan cities in the mainland. Technical know-how available with CIFT can be utilized in this case.

6.1.2 Modern Canning Plant

A canning plant for the production of 20,000 canned tuna per day at Agatti is an earnest proposal as far as economic feasibility is concerned. The plant should contain facilities for retort pouch processing machinery for processing fish curry and products in retort pouch. The plant will require test equipment and process validation equipment for providing consumer safety and quality to the product.

6.1.3. Modernisation/high quality *masmin* production

The traditional technique of *masmin* production has to be modernized for product quality and increased production. The modified methods developed by the CIFT for the production of high quality *masmin* can be adopted. Mechanical smoke chambers with facilities to control smoke density and temperatures are proposed. To assure continuous drying of the material without depending entirely on sun during rainy season artificial dryers (biomass based) may be used. These facilities have to be provided in all islands where excess tuna is available for *masmin* production. Six units with the mechanical smoke kiln and artificial driers are proposed.

6.1.4. Cured and dried products

There is good demand for salted and dried fish products in the mainland. Fishes, which are not locally consumed such as shark and rays, may be cured and dried. Curing yards may be established wherever sufficient quantities of the above varieties of fishes are available. Shark meat has been identified as a major commercial product of Lakshadweep Island.

The marketing of chilled tuna in the mainland is an economically viable proposal. This requires icing and rapid distribution to the markets in the mainland. If it is not possible for distribution on the same day the fishes may be kept under chill storage and transported to the mainland in the chilled condition. Proper chill storage at the receiving end also should be properly maintained.

6.1.5. Shark Products

There exists very good market for shark products both in the export market as well as mainland. The important products are shark cartilage, shark fin, shark liver oil, shark skin leather etc. Cleaned shark cartilage fetches 2-3 US $ /kg. while shark fin gets Rs. 2000/- to 5000/- per kg depending on the size of fins. Shark liver oil is a by-product, which has got good demand in the mainland. The price of the oil increases depending on purity and vitamin potency. Crude oil gets around Rs. 25/- per litre.

6.1.6. Waste utilization

Enormous quantity of waste is likely to accumulate which will be a serious threat to public health and environment. Proper methodology is to be adopted in all islands to utilize processing waste and convert into valuable commercial products such as organic manure, live stock feed supplement etc. Six numbers of waste utilization units have been proposed which will make use of the waste released from the processing plants.

6.2. Plant Capacity Utilization

Production at the targeted capacity is the objective of all production units. This calls for proper management of men and machinery. Putting these two resources most efficiently will achieve this objective.

6.3. Human Resources Development

In the present day marketing scenario only quality products fetch the right price and quality products can come out only from food processing plants managed by professionally qualified personnel. Proper training should be given to the Islanders on hygienic handling of fish, development of value added fish products, processing and packaging techniques, quality control etc. Technical persons should be given training on maintenance and repair of all processing facilities. The budgetary requirements for additional processing facilities are given in Table 18.

Table 18: Budgetary Requirements for Additional Facilities

	Facilities	**Units**	**Total cost (Rs. lakhs)**
1	Integrated fish Processing Plants for freezing, value added products, chill storage etc. comprising 25 tonnes chill storage, 150 tonnes cold storage and 2 tonne tunnel freezer.	3 places	555
2	Canning plant including pouch processing autoclave, canning retorts, process value addition equipment etc. with 5 tonnes, chill storage 10 tonnes cold storage	1 No.	245
3	Ice plant 10 tonnes capacity with desalination unit	3 Nos.	90
4	Building for curing yard, smoking centres etc.	3 Nos.	75
5	Smoke kiln	6 Nos.	15
6	Driers biomass based	6 Nos.	15
7	Fish waste utilization units	6 Nos.	30
8	Miscellaneous (strengthening the existing facilities including canning plant	--	100
	Total		**1125**

Major Fish Processing Equipment

No.	Items	Units	Amount (Rs. Lakhs)
1	Over Head Pressure Autoclave	2	20
2	High Speed Can Seamer, 2000 – 3000 cans per hour	4	30
3	Canning Retort, processing capacity 1800 – 2000 cans of 8 oz can	4	10
4	Boiler	1	6
6	Cold Storage, 150 ton capacity (-30^{0}C)	3	225
7	Chill storage, 25 ton capacity (-1^{0}C)	3	60
7	Tunnel Freezer, 2 ton capacity (-23^{0}C)	3	120
8	Test equipment	-	50
	Total	-	521

Abstract Economics of Fish Processing

i) Fish Curry in Retort Pouch

1. Equipment consisting of autoclave, Air surge tank, Compressor, Water pump, Boiler, Exhaust line, Sealing machine, temp. recorder, Chill cabinet, Frying pan, Kitchen equipment etc : Rs.42 lakhs

2. Land required 400m^2 : Rs. 5 lakhs

3. Building : Rs.15 lakhs

Production cost for 750 kg curry/day

1. Working capital for 75 working days for raw material, fuel, packaging materials, salary, wages & transport : Rs. 45 lakhs

2. Total investment : Rs.107 lakhs

Remarks

Abstract Economics of Fish Processing

ii) Fish Canning Plant

1. Equipment consisting of autoclave, Boiler, Exhaust line, Sealing machine, utensils etc. : Rs.25 lakhs

2.	Land and Building	:	Rs.20 lakhs
3	Production cost for 10000 cans (5 tons raw materials)/day		
	Working capital for 75 working days for raw material, electricity, fuel, salary, wages & transport	:	Rs. 45 lakhs

Remarks

With an investment for equipment Rs.25 lakhs the total investment is Rs.90 lakhs including land, building and working capital for a plant of production capacity 10000 cans per day. The cost of production of a fish can (net weight185g) is worked out to be Rs.25/-

iii) Fish Waste Utilization, Production of Organic Manure & LiveStock Feed Supplement

iv) Production of fish fillets

1	Refrigeration Equipment, machinery, cold storage, chill storage, Ice making machine, Balancer, Processing tables, facilities of Quality Control Lab etc.	:	Rs.150 lakhs
2	Land and Building, facilities of vehicles, effluent treatment	:	Rs.35lakhs
3	For production of 2.5 tonnes of fillets/day. Working capital for 75 days for raw material, electricity, packing materials, salary, wages, transport etc.	:	Rs.150 lakhs

Remarks

An investment of Rs.335lakhs (equipment, land and building and working capital) is required for a freezing plant of production capacity of 2.5 tonnes per day. The production cost per kg of boneless fish fillets works out to be Rs.150/-.

6.4.Creation of retail outlets

Retail outlets for Lakshadweep brand tunas and tuna products may be created in the metros and the major cities in India.

7. OPEN SEA MARICULTURE

It has been long recognized that the Lakshadweep Islands possess immense potential for the development of mariculture due to the availability of numerous lagoons. These natural protected waters offer plenty of scope for large-scale mariculture ventures, which can play a vital role in the development of fisheries entrepreneurship in the islands.

It is further recognized that a number of marine species of global interest found exclusively in the islands are endangered and have been recently placed in the Schedule I and IV of the Indian Wildlife (Protection) Act. The overexploitation of these valuable resources, coupled with their slow regeneration capacities and the occurrence of catastrophic natural disasters have led to a situation calling for implementing conservation measures. In this context, mariculture, or more aptly *conservation mariculture*, can play a vital role in rebuilding of endangered and vulnerable marine stocks.

This section of LAKFISH will outline a development strategy for entrepreneurship in mariculture in the islands with a view to enhancing the livelihood opportunities of the local people.

7.1.Culture Potential

The Lakshadweep Islands have several lagoons with varying depths and different substrata, which are suitable for several types of mariculture operations. Ideal situations exist for raft and cage culture in the lagoons and pen culture in shallow lagoons. In a world, which is increasingly, concerned with contaminant loads in farmed aquatic species, the unpolluted waters of these islands offer immense scope for farming of high value tropical marine species suitable for global markets.

The mariculture technologies developed and available in the country today are by and large eco-friendly and can be effectively used without damaging the fragile ecosystem of the islands.

Furthermore, the growing tourism industry in the islands can be strengthened by the implementation of conservation mariculture, which in many parts of the world is attracting tourists. The ecotourism potential of hatcheries and grow-outs of endangered species like the turtles, gastropods, giant clams and sea cucumbers are to be tapped.

7.2.Areas suitable for development of Mariculture

The following details are provided as potential sites for the different culture systems.

Method of Farming	**Depth Zone (m)**	**Potential Sites**
Raft/Cage/ Longline	05-30	Kalpeni, Bangaram and Minicoy

7.3.Candidate Species

7.3.1.Finfishes: A number of marine finfishes available in the islands are amenable for mariculture. These include *Siganus* sp. (rabbit fish); *Lutjanus* spp. (snappers); *Epinephelus* spp. (groupers); *Caranx* spp. (jacks and trevallies); *Thunnus* spp. (tunas). These species have high value in international markets.

7.3.2.Marine Ornamentals: The policy of the Lakshadweep Administration is to prevent exploitation of ornamental fishes from the wild. However the Administration is encouraging setting up of hatcheries and production of ornamental fish under controlled conditions. In *LAKFISH* mariculture of ornamental fish is suggested. Global trade in marine ornamentals is a multi-billion dollar industry. The research institutes have developed technologies for the hatchery and grow-out of clown and damselfishes. *LAKFISH* recommends establishment of 100% EOUs in two locations namely, Agatti and Kalpeni. An ornamental fish hatchery has already been established in Agatti by the LDCL.

7.3.3. Lobsters: Six species of spiny lobsters namely *Panulirus homarus, P. ornatus, P. pencillatus, P. versicolor, P. polyphagus* and *P. longipes* have been identified as suitable

for farming/fattening in the islands. These species are also amenable to cage farming in integrated systems. Live lobsters are the most expensive of the traded seafood resources.

7.3.4.Molluscs: Lakshadweep Islands are a virtual paradise of molluscan biodiversity. The groups include a large variety of bivalves and gastropods.

7.3.5.Pearl oysters: The amenability of the introduced pearl oyster *Pinctada fucata* has been demonstrated through a demonstration project in Bangaram Island. Recently the CMFRI has been able to source blacklip oysters from Minicoy Island. There is great scope for developing a black pearl production system in the islands.

7.3.6.Giant clams: Many of the reef flats of Lakshadweep Islands have rich resources of giant clams like *Tridacna crocea, T. maxima* and *T. squamosa.* These extremely beautiful and long-lived animals with a peculiar life history have always been sought-after by shell collectors, marine aquarists and shell craft artisans. As a conservation measure and to promote its trade as a marine aquaria commodity, it is necessary to start seed production and farming of these organisms.

7.3.7.Octopus: Octopuses are considered as a delicacy and a unique type of spear fishing is employed by the islanders to capture this resource. There is scope for developing farming techniques for octopus considering its export value.

7.3.8.Sea cucumbers: Because of depletion of stocks in natural beds in the mainland seacucumbers have been placed in Schedule I of the Indian Wild Life Act. 1972. similar to giant clams. The hatchery technology for *Holothuria scabra* has already been developed by CMFRI. Stock rebuilding programs have to be initiated to conserve and protect the species and to revive the trade on the species as a cottage industry. It is recommended that the Lakshadweep Administration may approach Ministry of Environment and Forest and obtain permission to collect selected species of sea cucumber for developing broodstock, establish hatchery and grow- out system and to export products.

7.3.9.Seaweed: Chemical derivatives such as algin and agar from seaweeds have immense industrial applications. Agarophytes such as *Gracilaria* and *Gelidiella*, and carrageenophytes such as *Hypnea and Kappaphycus* are potential species for seaweed mariculture. There are dominant alginophytes such as *Turbinaria*, and *Sargassum* available in the Islands. The research institutes have developed low-cost technologies for seaweed farming through vegetative propagation using ropes and nets. Production and export of raw materials itself could be a lucrative activity for the islanders.

7.4.Technology availability and its adoptability

Listed below are the mariculture technologies available and those, which need to be outsourced. It must be borne in mind that the technologies developed in the mainland and elsewhere have to be field-tested in the islands on a pilot scale before launching large scale commercial farming programmes. These pilot scale programmes need R&D from the concerned research institutions and this has to be supported monetarily by the Lakshadweep administration. It is imperative that all the technologies, which are to be commercialized in the islands, are modified and field-tested in a similar manner.

As regards the technologies, which are to be outsourced, a similar mode of operation should be envisaged (Table 19).

Table 19. Technologies available and those, which need to be outsourced

Technologies available	**Adaptation/Modification required**	**Time needed for adoption**	**Implementing organisation**
Pearl culture and mabe pearl production using *Pinctada fucata*	Needs modification to suit *P. margaratifera*	3 years	Already being addressed by CMFRI in A & N Islands
Marine ornamentals	Technology available for clownfish and damsels but needs adaptation to several other endemic species	2 years	CMFRI
Lobster fattening	Technology available for *P. homarus* and not tested for other species	3 years	CMFRI/ NIOT
Sea cucumber culture	Only hatchery technology is perfected for *H. scabra* and *H. atra*. Grow-out techniques have to be developed	4 years	CMFRI
Seaweed culture	Techniques available in the mainland are for agaraphytes. Modifications have to be made for alginophytes, which are dominant in the islands. Carageenan producing *Kappaphycus* can also be tried. Farming techniques for this species developed in the mainland have to be adapted to Lakshadweep conditions.	3 years	CMFRI/ CSMCRI
Technologies to be Outsourced/Developed			
Marine finfish hatchery and cage farming	Available in southeast Asia. Experts to be invited for setting up of demo unit. CMFRI successful in sex reversal and spawning in groupers, but larval cycle not complete. CMFRI is embarking on a cage farming project with DAHD&F funding during 2005-06.	4 years	SEAFDEC/ CMFRI
Tuna fattening	Considerable amount of undersized skipjack tuna are taken by pole and line vessels. With little innovation and expenditure these can be fattened to fetch higher prices.	2 years	CMFRI

7.5.Cage Culture

The open sea cage culture has been expanding in recent years and it has made possible the large-scale production of commercial finfish in many parts of the world and can be considered as the most efficient and economical way of raising fish. The beginning of marine farming in cages dates back to 1950's with the commercial culture of the yellow tail *Seriola quinqueradiata* in Japan. Since the 1970's, Thailand has developed cage culture techniques for two important marine finfish – the sea bream (*Pagurus major*) and grouper (*Epinephelus* spp). In Korea, by the end of 1980's, cage culture of the olive flounder (*Paralichthys olivaceus*) and black rockfish (*Sebastes schlegeli*) was established and developed into a successful aquaculture industry in 1990's. Cage culture of groupers (*Epinephelus* spp) in the Philippines has been practiced since 1980's. Currently many species have been cultivated in various designs and sizes of cages in Asia, Europe and other parts of the world. Fish culture using cages has proven to be technically and economically viable in most countries. In India, the cage culture of marine finfishes is almost a new area of research and hence requires priority attention. The bays, creeks and inlets of the islands are best suited for large-scale cage culture of finfishes. The cage culture system can optimize the carrying capacity per unit area since the flow of current brings in fresh seawater and removes metabolic wastes, excess feed and faecal matter. Cage culture is a high input farming practice with high economic returns. It paves the way for the maximum use of available water and reduces pressure on land resources.

7.6.Juvenile tuna fattening: Tuna farming in cages is one of the most lucrative and emerging mariculture practices in several countries. Many nations have drawn up new development programs to initiate tuna farming. Since large amount of tunas will be exploited as proposed in the LAKFISH and since undersized tunas are always a component of catches, it is suggested that juvenile tunas caught are fattened in cage farms.

An indicative cost-benefit analysis prepared for a project based on economics of commercial marine finfish farming in Singapore is shown in Table 20.

Table:20. Detailed budget costs of floating cage farm. (All estimates and projections are approximate and are likely to change)

Cost Analysis		Cost (Rs in lakhs)
CAPITAL INVESTMENT		
1.	Fixed assets Farm comprising 20 (4x4 m) floating cages + work hut, boats and equipments	26
2.	Working capital (variable costs) Variable costs for one culture cycle of 8 months duration	10
3.	Total capital investment, (1) + (2)	36
OPERATIONAL COST OF PRODUCTION		
4.	Variable costs	10
4.1	Manpower (1 manager @ 15,000 month $^{-1}$) + (2 farm hands @ 6000 month $^{-1}$) x 13 months year $^{-1}$ [inclusive of bonus]	3.51
4.2	Fuel, maintenance and miscellaneous [25,000 per month x 12 months year^{-1}]	3
4.3	Fry [@ mean price Re 1 each]	0.5
4.4	Feed [trash fish @Rs.5000 tonne $^{-1}$ and feed conversion ratio 4.5:1]	3
5.	Projected Annual production (t) [At 60% survival and mean of 0.6 kg per fish]	18
6.	Projected Sale price (Rs. 1 lakh t^{-1}, ex-farm)	18

7.7. Broodstock Development and Management

A Broodstock Development and Management Centre needs to be developed for major culturable species at an appropriate place in the island for steady supply of the brooders to the hatcheries. This is essential because broodstock from mainland or abroad is not permitted to be introduced in to the islands.

7.8.Seed Requirement and Hatchery Development

Unlike shrimp farming, mariculture is an entirely new practice requiring specific needs for the diverse culturable species.

Finfish:

Marine ornamental fish hatcheries as 100% EOU are to be established in Agatti and Kalpeni in the first year.

Molluscs and Other Groups:

A gastropod and sea cucumber hatchery of moderate capacity of 1 lakh juveniles per year may be set up to address the conservation mariculture programmes. This can be located in any one of the islands, so that released juveniles are not fished immediately.

7.9.Nutrition and Feed Management

Cage farming is dependant on trash fish and pellet feeds. Low value fishes like the sardines and anchovies, which do not have demand in the local markets, can be utilized as feed for cage farmed carnivorous fishes. Molluscs do not have any specific feed requirements, as they are primary consumers.

7.10. Environment Management

The environmental changes due to expansion of mariculture in the recent past have become a major international concern. Organic enrichment resulting from cage / pen culture is of much ecological significance. This is of extreme concern at Lakshadweep Islands due to the sensitive coral reef ecosystem. *LAKFISH* recommends that EIA studies should go hand in hand with development of new mariculture practices in the newly identified mariculture sites.

7.11.Health / Disease Management

Since mariculture practice is new in the mainland, diseases are not very much prevalent. However, as a measure of caution, *LAKFISH* recommends that constant disease surveillance and contingency plans should be undertaken by the Department of Fisheries

7.12.Policy Issues

Development of open sea mariculture is a new area of fisheries development, and hence, a large number of issues need to be sorted out before this becomes a reality. Water bodies are common properties and traditional, commercial, defense, social, environmental and civil rights and concerns are to be addressed. A master plan needs to be developed preferably on a GIS platform. The legal issues related to lease, rights etc are to be put in to place so that those who are willing to invest on the infrastructures will have a right on their properties and water bodies for a sufficiently long period so as to realize profitability in the commercial venture. Issues related to safety, security, poaching, insurance, crisis or disaster management are to be built into the system and in to operation.

7.13.Infrastructure Requirement

In order to implement the development initiative outlined in this section of the *LAKFISH*, the following infrastructures have to be put in place by the Administration. These would include land and farm development, shore establishments, energy and water supply, transport and communication, processing and storage and trade facilities. Some of these are common infrastructure facilities.

Hatchery Systems:

- Two units of marine ornamental culture systems as 100% EOU at Androth and Kalpeni.

Farming systems:

- Three cage farm units each with 2 m x 4 m x 4 m floating cages for marine finfish and lobsters at Kalpeni, Bangaram and Minicoy.
- Rafts (20 nos.)/longlines (10 nos.)/Pens (15 nos.) for bivalves and seaweeds

Ancillary Systems:

- Juvenile fish chain in different islands for collection of wild seed for cage farming
- Trash fish collection centre with freezing facilities for cage farm feeds

The financial targets for various activities of mariculture work out to Rs. 811 lakhs (Table 21).

Table 21: Fiscal targets (Rs. in lakhs) and time frame for mariculture factored with incremental appreciation every year.

	Phase- I				**Phase-II**			**Phase - III**				Total
	2006-07	2007-08	2008-09	2009-2010	2010-11	2011-12	2012-13	2013-2014	2014-15	2015-16	2016-17	
Ornamental Fish hatchery including tuna live baits	120											120
Bivalve hatchery	50											50
Cage farms	50			75				100				225
Rafts	5	1	1	1	3	8	2	2	2	3	3	31
Longlines	2	4	3	3	3	4	8	5	10	12	12	66
Pens	6	2	2	2	2	2	8	2	2	2		30
Fry chain	10	15	20									45
Trash fish collection	25		35				50					110
Gastropod & Cucumber hatchery			80									80
Ocean nurseries for giant clam		2		3		4		5				14
Coral nurseries	2		3		7		8		10		10	40
TOTAL	**270**	**24**	**144**	**84**	**15**	**18**	**76**	**114**	**24**	**17**	**25**	
Phase wise Total	**522**				**109**			**180**				**811**

8. PRODUCT DIVERSIFICATION AND MARKET EXPANSION

Autonomous investment is highly essential for the development of infrastructure facilities to trigger private profitability and develop entrepreneurship. Although substantial fishery potential is there around Lakshadweep islands, limited land availability, water scarcity and inadequate power supply serves as the major bottleneck for optimum production. The fishery economy is still operating only as a sustainable activity and not a commercial enterprise. Whenever surplus production is there beyond local consumption, they are converted as *masmin*, which has not created adequate or required consumer preference even in the Indian domestic marketing system.

With increasing production in capture fisheries, almost 50 percent is for local consumption including the preparation of *masmin,* which is a reasonably remunerative supplementary occupation of womenfolk. The gross revenue generated by *masmin* preparation and supply to the domestic as well as exports will be about Rs. 1200 lakhs in the I phase, Rs 2300 lakhs in the II phase and Rs 3750 lakhs in the III phase, with the price rate of Rs 200, 230 and 250 per kg respectively. The employment potential in this sector alone will be 18,000 labour days in the first phase, 28,000 labour days in the second phase and 40,000 labour days in the third phase.

Product Diversification and market expansion both in the domestic and exporting channel is inevitable for triggering economic development of Lakshadweep islands. In this context 50 percent of the Tuna catch in the I, II and III phases are specifically earmarked for processing, value addition and export marketing.

The expected increase in the outflow mainly focused on fishery exports and consequent revenue realised per annum in each phase is estimated and given in table 22. Altogether an annual export earnings of Rs 6055.3 lakh in the I phase, Rs 19710.5 lakh in the II phase and Rs 37516 lakh in the III phase is anticipated. *Sashimi* grade tuna forms 25 to 35 percent of the gross revenue generation through exports.

Table 22: Annual production targets and marketing of various products

Sl. No	Products	**Phase I**		**Phase II**		**Phase III**	
		Quantity tonnes	Value Rs. lakh	Quantity tonnes	Value Rs. lakh	Quantity tonnes	Value Rs. lakh
I	**Exports**						
1	Frozen whole for export	1200	1200	1600.00	1920	2400	4320
2	Sashimi Grade Tuna	-	-	1200.00	6600	1600	10400
3	Smoked and frozen tuna loins	~	~	350.00	875	700	2450
4	High quality mas	250	625	250.00	700	500	1500
5	Value added tuna products		-	225.00	1125	450	2700
6	Frozen whole fish for export	340	340	565.00	678	900	1620
7	Battered and breaded products for export	120	720	200.00	1400	320	2560
8	Mince based VAP, for export	600	3000	1000.00	6000	1600	11200
9	Shark cartilage	22.5	20.25	37.50	37.5	60	66
10	Shark fin	7.5	150	12.50	375	20	700
	Subtotal	2540	6055.3	5440.00	19710.5	8550	37516
II	**Internal Markets**						
11	Fresh tuna in chilled form for distribution in mainland	900	405	1350.00	810	1800	1350
12	Salted and cured shark meat	225	135	375.00	262.5	600	480
13	Shark liver oil	15	37.5	25.00	75	40	140
14	Canned tuna	333	810	533	1440	666	1980
15	Waste conversion into organic manure	2500	550	4000	1080	6000	2160
16	Masmin	600	1200	1000	2300	1500	3750
17	Other fishes	3875	1937.5	6112.5	3667.5	8729	6110
	Subtotal	8448	5075	13395.5	9635	19335	15970
	Grand total	**10988**	**11130.3**	**18835.5**	**29345.5**	**27884.5**	**53486**

It is worth to note that the conversion of fish wastes into organic manure alone contributes about Rs 550 lakh per annum at the end of the I phase, Rs 1080 lakh in the II phase and Rs 2,160 lakh in the III phase.

The product development and market expansion need to be accorded top priority in catering to demand of domestic marketing system. Supply of Lakshadweep fishery products in the internal marketing in the mainland is highly essential for maintaining the long-term development of fisheries in Lakshadweep. Hence it is proposed to develop a potentially competent internal marketing system which will diversify the risk and act as shock absorbers in times of crisis. The proposed development of the internal markets in the three phases generates Rs. 5075 lakhs in phase I, Rs. 9635 in phase II and Rs. 15,970 lakhs in phase III.

In this context necessary infrastructure coupled with retail outlets of selling Lakshadweep brand fish and fishery products is essential. Establishing retail outlets and regular supply of Lakshadweep brand fishery products in the metros in the I phase and subsequent expansion in the II and III phases taken by Lakshadweep Development Corporation Ltd. (LDCL) will definitely boost the economic growth of the islands. This can be further linked with the Departmental and well-established stores of the entire country with vertical and horizontal expansion of cold chain.

LDCL may develop tie-up with Government fisheries agencies in Kerala and Karnataka to make use of their cold storage facilities in the main land to store and market the catch from Lakshadweep.

9. ECO-TOURISM

The eco-tourism is usually designed and promoted based on the natural resources of that particular region in order to create employment opportunities, for the protection and conservation of the ecology and the ecosystem etc. Lakshadweep being coral islands with enchanting lagoons holding various types of beautiful and rare marine organisms should develop eco-tourism based on these resources. The most ideal would be, sport fishing, diving etc. at specially designed/developed and protected areas with the help of Artificial Fish Habitats/Artificial Reefs both inside the lagoons and open sea off Kavaratti, Kalpeni, Kadmat, Minicoy, Agatti and Bangaram. It is to be introduced and promoted as a self-employment opportunity to the local youths through Self Help Groups. Glass-bottom boats may be introduced for coral reef watch.

9.1.Sea turtle park and Marine mammal watch:

The Lakshadweep Islands are one of the most important nesting grounds for sea turtles. Four species such as the olive ridley, green turtle, hawksbill turtle and the leatherback turtle are reported to nest along selected beaches. All the species are declining rapidly and the leatherback is listed in the IUCN Red Data book. A programme of collecting turtle eggs from their nesting grounds, hatching them and release of the baby turtle into the sea has been taken up by many maritime states in the mainland India. A similar programme should be initiated in Lakshadweep Islands with emphasis on ecotourism. The tourists should have the facility to watch baby turtles hatching out and release them to the sea. There is immense scope for establishing a sea turtle park.

Lakshadweep Sea is a major abode for marine mammals such as dolphins and whales. Marine mammal sighting cruises could be arranged as a part of ecotourism programme.

9.2.Sport fishing vessels

It is learnt that there is ample scope for sport fishing around the islands such as Kavarathi, Kalpeni, Minicoy, Agatti and Kadamat. Hence 5 FRP Sport Fishing vessels of

length 12m, breadth 3.5 m, depth 1.5 m fitted with inboard engine developing 80 to 90 hp can be introduced in phased manner. Initially one such vessel can be introduced. There shall be a cabin with berth for two persons in this boat. One VHF, one GPS, three life jackets and one life buoy can be provided on this. The cost of each vessel will be about Rs. 25.00 lakhs.

In addition to the sport fishing vessels, five glass bottom boats may be introduced in the islands mentioned above for tourism and eco-watch programmes. The cost of each vessel will be Rs. 20.00 lakhs.

Oceanarium :

A small marine aquarium already exists in Kavarathi. This has to be remodeled into a state of the art Oceanarium with high investment. This can be converted into a grand tourist attraction. For oceanarium budget allotment of Rs.1000 lakhs is suggested (Table 23).

Table 23: Investment requirement for eco tourism (Rs. In lakhs)

Item	Phase I	Phase II	Phase III	Total
1. Sport fishing vessels	50	75	-	125
2. Glass bottom vessel	40	60	-	100
3. Oceanarium	1000	-	-	1000
Total	1090	135	-	1225

10. RESEARCH PROGRAMMES

The proposals made in *LAKFISH* for increasing fish production through capture fisheries and mariculture, and development of fish processing should be strongly supported by research programmes. It is suggested that the following research programmes on capture fisheries and mariculture may be taken up in association with CMFRI, CIFT, IFP and FSI and on marketing with MPEDA:

10.1. Capture fisheries and fish processing

i. Revalidation of fisheries potential needs to be taken up on a priority with the help of CMFRI and FSI.

ii. The Lakshadweep Administration has recently installed 30 FADs in the Lakshadweep Seas with the help of NIOT. By involving Minicoy Centre of CMFRI, the Department of Fisheries should take-up the following tasks: (a) monitoring the performance of the FADs, (b) monitoring the catch and income of the fishermen, (c) develop guidelines, and draft rules and regulations for the FADs, and (iv) educate the fishermen on the advantages and disadvantages of the FADs for long-term sustainability of the resources.

iii. The tunas fetch very low price (Rs. 20 per kg) to the fishermen. Since storing, preserving, freezing and processing facilities are not available in the islands, the idea of inducting mother ships with processing facilities is gaining momentum among the fishermen and the island administration. In consultation with the CIFT and MPEDA, the Island Administration may (a) identify the number and type of mother ship, (b) developing value added products and (c) developing strategies for marketing the tunas as well as other fishes. Since the NIOT has deployed 30 FADs and the tuna catch is expected to increase, the need for quality preservation and processing onboard and marketing assumes greater importance.

iv. The Fishery Survey of India is going to undertake a tuna tagging programme in collaboration with CMFRI. The Administration should extend support to the

programme to understand the migration and seasonal availability of tunas in the islands.

10.2. Mariculture

v. Research may be initiated on pearl culture in the lagoon. For this, implanted oysters could be transported initially from the mainland and pearl culture may be demonstrated on a pilot scale to the interested islanders. Pearl culture in the lagoons by using the blacklip pearl oyster *Pinctada margaritifera* may also be initiated. For this, a good hatchery with running water facility is required.

vi. Resource survey and R&D for culture technology of the abalone, *Haliotis ovina*, a highly valued resource for pearl production as well as for food may be initiated.

vii. Research on breeding and culture of the giant clam *Tridacna* sp may be taken up.

viii. Research on the farming of seaweeds such as *Gracilaria* spp. and other seaweeds, which could be sourced for agar agar production, could be initiated.

ix. Research on backyard ornamental fish hatchery can be initiated for sea anemones, clownfishes and damselfishes and other ornamentals (fishes and invertebrates).

x. Considering the availability of lobsters, breeding programmes should be initiated for the spiny lobsters *Panulirus pencillatus*, *P. versicolor* and *P. ornatus*. Research on cage culture (fattening) of spiny lobsters in the lagoon should be initiated by identifying suitable type of cages.

xi. For the hatchery programmes, a live feed culture facility should be established.

xii. Considering the exploitation of a large number of juveniles (< 30 cm length) of tunas, there is good scope to grow the juvenile tunas in cages. The large quantities of offal waste from *masmin* preparation can be used for feeding the tunas in cages. It is estimated that 30% of wet weight of tunas used for *masmin* preparation is discarded into the sea.

xiii. The NIOT has installed a desalination plant in Kavarati and has plans to install more plants in other islands. For this, cold seawater is going to be pumped from a depth of about 400 m. It is understood that only 10% of the water drawn will be converted into freshwater and the rest will be let out into the sea. In consultation

with the scientists of NIOT and CMFRI, the Administration may examine the possibilities of using this clean deep sea nutrient enriched water for hatchery and mariculture purpose.

10.3. Environmental Concerns

xiv. Climate change, viz., ocean warming and sea level rise are evident throughout the globe. These changes will have extreme adverse effect on the Lakshadweep Islands. The Administration should give priority to this crucial issue and collaborate with CMFRI and Indian Institute of Tropical Meteorology, Pune to monitor the climate parameters and predict the impact on the islands and fisheries.

xv. In collaboration with CMFRI and CIFT, the Administration should have a floating laboratory with stay-in facilities in Minicoy lagoon.

It is recommended that a total amount of Rs 1,000 lakhs be earmarked for funding research programmes.

11. HUMAN RESOURCE DEVELOPMENT

11.1.Training

While formulating a long-term plan for fisheries development, particularly considering the isolation of this island territory, emphasis should be given for manpower development. The training facilities available with the Administration are very meager. There is only one fisheries training centre (FTC) at Amini. The manpower and the equipments available at this centre are inadequate to meet the requirements of the future developments envisaged. Manpower development in the following areas is essential:

Vessel crew

Small mechanized vessels - Training courses are available, but have to be upgraded by arranging refresher courses with CIFT and CIFNET to expose the trainees to recent advances in the fishing gear technology.

Large mechanized vessels – Training from skipper to deckhand level is required. The vessels being sophisticated with long sea endurance, calling at various ports at these islands, the personnel commanding the vessel should be competent. – Agencies for such training are CIFNET and FSI.

Shore Mechanics

To attend the maintenance and repair of engines, various other machineries, equipments, etc. Agencies – FSI and CIFNET.

Radio Telephone Operators

Communication from ship to ship, ship to shore, and shore to shore is essential. Agency – CIFNET.

Training in Fishing Gear Technology

Essential steps necessary to build up fishing gear technologies who will be able to design, fabricate, and undertake repair works. Agency –CIFNET, CIFT and FSI.

Teachers' Training Course

It is essential that teachers/instructors of the training course in the islands get exposure to the advances in fishing technology from time to time – Agency CIFT/CIFNET/FSI.

Training in Fish Processing

Training in fish handling, processing and refrigeration and other new methods; Agency-CIFT/IFP.

Training in Mariculture

Training in open sea mariculture practices and activities: Agencies - CMFRI.

A team of experts from CMFRI would be able to arrange short-term training courses/programmes in the island territory itself as and when necessary. The basic infrastructure required for the training in all field shall be created at the training Centre. Therefore, it is suggested to have training schedules prepared on an annual basis and invite trainers from mainland institutions like CMFRI for offering specific training to local youth and fishers under the logistics of the skeletal staff of the FTC.

Costs for such programmes including TA/DA for the trainers shall be met from the funds of the Department of Fisheries. Such programmes shall be given wide publicity and the necessary infrastructure shall be built up in the Training Institute in consultation with the partner institutions. In this way, the required skilled manpower can be developed in the islands on a continuing basis.

The training schedules will be prepared and announced well in advance and youth encouraged to take advantage of the scheme. LAKFISH considers that this is the best and most practical way to build up the necessary human resource in various fields in the Islands.

For HRD programmes budget allotment of Rs.500 lakhs is suggested .

12. INVESTMENT PROFILE AND ECONOMIC BENEFITS

Massive public investment and government supported private investment is essential to catch 62 % of the potential resources from the Lakshadweep waters from the current level of 10 % utilisation. Based on the suggestions given in each phase of the developmental agenda, the capital investment required on different items have been worked out and given in Table 24. The gross investment needed is Rs. 18,941 lakh, in which the introduction of new type of vessels alone constitutes 69 %. About 25 % of the gross investment is required in the I phase, 30 % in the II phase and 45 % in the third phase.

Table 24 : Investment requirement for fishing units for Lakshadweep fisheries

(Rs. in Lakh)

Sl. No	Item	Investment			Total
		Phase I	Phase II	Phase III	
I	**Upgradation of Existing boats**				
	1. Traditional units	66	-	-	66
	2. Pole & Line units	546	-	-	546
	3. Gillnetter cum troll lines	140	-	-	140
II	**Introduction of New Vessels**				
	1. Pole & lines	-	612	-	612
	2. Gillnetter/troll lines	-	295	-	295
	3. Wooden Maldivian type	-	1500	1500	3000
	4. Longliner cum Gillnetter	-	2250	5250	7500
	5. Mother/collector vessel	800	-	800	1600
III	**Mariculture development**	270	285	256	811
IV	**Processing facilities**	1152	272	222	1646
V	**Eco-tourism**	1090	135	-	1225
VI	**Research programmes**	400	300	300	1000
VII	**Human Resource Development**	250	130	120	500
	Total	**4714**	**5779**	**8448**	**18941**

The growth rate of population during 1991 to 2001 is about 17 percent. Assuming the same growth rate, the total population of Lakshadweep islands during 2011, will be about 71,000 and 77,000 in 2017. The additional per capita investment as per the

development agenda, at the end of second phase is Rs. 14,462, which will be reaching to the level of Rs. 24,306 at the end of the III rd phase (2016-17). This increase in per capita investment could be achieved over a period of 10 years.

Excluding the local consumption, the gross revenue generated per annum at the end of the II phase is Rs. 30345.5 lakh and Rs. 55486 lakh at the end of III phase (2016-17) (Table 25). Almost 50 percent of the gross revenue generated will be spent towards production cost excluding wages to labour. The profit and wages to labourers comes about Rs. 15172 lakh per annum in 2009-10 and Rs. 27743 lakh per annum in 2016-17. The additional annual percapita earnings of fisherfolk in Lakshadweep will be Rs. 21369 at the end of I phase, which will reach to a level of Rs. 36030 at the end of III phase (2016-17).

Table 25: Anticipated additional annual gross revenue in different phases

Rs in lakh

Sl. No	Item	**Phase I**	**Phase II**	**Phase III**
1	Exports	6055.3	19710.5	37516
2	*Masmin* (local) & other products for internal markets	5075	9635	15970
3	Mariculture and eco-tourism	200	1000	2000
	Total	11330.3	30345.5	55486

The capital turn over ratio is very high in all phases and the benefits in terms of marginal productivity and earnings surpass the investment. Hence the implementation of the proposed development agenda is economically feasible and highly advisable. The increase in per capita earnings coupled with better employment opportunities will lead into socio economic empowerment of islanders. The advantage is that the socio economic benefits will percolate to the population of lowest income strata and enhance their welfare and standard of living.

13. POLICY AND ADMINISTRATIVE REFORMS

13.1.Revamping fisheries Department :

a). A total revamping of the Fisheries Department to rejuvenate and strengthen with men, materials fund and powers is necessary. Initially an Advisory Board/Council has to be constituted under the Secretary, Fisheries with the active participation, involvement and guidance of the R & D agencies and members from Dist.Panchayath/Panchayath Presidents of various islands and Chief Councilors. This is essential to identify the real issues and needs and would help in the implementation of the developmental programmes. The Board/Council will discuss, plan and facilitate the execution of the annual targets and positively to review the progress in the III quarter to take corrective measures in the last quarter.

b). Three divisions/ sections, *viz.* a) Resource Assessment Division, b) Co-operative and Marketing Division, & C) Research, Extension and Education Division need to be created under the Department of Fisheries. All the divisions should have required manpower, funds and powers by the end of the XI plan. Initially, these Divisions/Sections can work and organise important programmes with the assistance and guidance of the respective R & D organisations. They can co-ordinate and implement the immediate essential programmes with their active participation. The Resource Assessment Division/Section should conduct a detailed survey of the crafts and gears in vogue and the census of fishermen population. This has to be completed during 2006-07, which will form the basic statistics for the XI plan planning. Besides, the Division/the Fisheries Department should systematically start collecting the species-wise, gear-wise catch and effort data from all the inhabited islands using the existing facilities/manpower under the guidance of CMFRI. The data collection process may be continued incorporating more characteristics with the help of trained personnel (2 each in major islands and one each in minor islands) specifically recruited for the purpose.

c). Research, Extension and Education Division should be able to cater to the needs of the Islands including the HRD by the end of XI plan. Initially, it should identify the need-based problems and seek the guidance and assistance of the respective R & D agencies and then co-ordinate and execute the programmes. The FTC at Amini should be strengthened and properly equipped for the required purposes with the help of the respective R&D agency.

13.2.The Lakshadweep Marine Fishing Regulation 2000 (MFR 2000) :

a.) MFR 2000 aims at sustainable development of fisheries for achieving the goals of food for all, economic growth and employment generation in the islands. Various steps/measures can be adopted for this and the most important and immediate step should be to market the produces. The co-operative and marketing Division/Section can be either a section of the department or an independent autonomous powerful body like a Fisheries Development and Marketing Agency. The agency can work in collaboration with the active support of the organizations like MPEDA for marketing and exporting the produces. Besides, it should organize regular *melas*, in the mainland in line with the IRDP *melas*, to popularize the various fish and fishery products. The agency should procure the produces from the fishermen/SHGs and market with proper brand name. The shore based cold storage chains, mother ship etc. should be under the control of the Agency and to be operated under the joint venture mode with private investments. The Agency should export the products directly or through other established reputed exporters. Besides, the Agency should meet/fulfill the requirements of the fishers by supplying them with the necessary inputs/materials/implements/fuel etc. on credit basis or soft loans.

b) As per the MFR 2000, the new generation fishing boats licensed for fishing in the EEZ should be encouraged to fish in the Lakshadweep waters. Therefore, licenses for the mainland fishing vessels to be issued i.e. restricted, controlled and conditional entry permits to limited vessels only.

c). The DoF may issue fishing licenses to mainland boats engaged in DGN/LL/HL/Trolling to fish in the EEZ of Lakshadweep. Initially 100 such licenses could be issued, which would bring an estimated 5000 tonnes of quality fishes every year (assuming a catch of 50 t/boat/year). The license fee may be fixed as Rs.1 lakh per boat per annum (to be revised upward or downward based on the response) and this would bring annual revenue of Rs.1 crore to the DoF. This amount should be channeled into a corpus known as Fisherman Welfare Fund, which is to be used for the benefit of the Island's fishermen in times of natural calamities and disasters.

Obviously, the success of such a venture would depend on the strict monitoring, control and surveillance (MCS) being enforced by the DoF and the newly formed Marine Enforcement Force or the Coast Guard. The DoF should be strengthened in terms of manpower for carrying out high-sea inspections, collection of log-sheets, and issue of licenses at Cochin etc. The issuing of the licenses must be conditional, that the boats should hand over the copies of the log sheets containing the species wise/ group wise total catch, area of fishing, endurance etc. to the Authorized Officer at Cochin on each trip.

13.3.Suheli to be made as Exclusive Fisheries Island

The MFR 2000 aims at sustainable development of fisheries for achieving the goals of food for all, economic growth and employment generation in the islands. Various steps/measures can be adopted for achieving this; creation of an Exclusive Zone would be a right step towards this. Suheli with two islands,(Valiyakara and Chariyakara)very vast lagoon and highly productive open sea is the most ideal zone for the purpose. The energy requirement may be met from the windmills and solar energy and rainwater may be harvested in addition to the new NIOT model desalination plant for freshwater.

13.4. Awareness programmes

The beliefs and mental blocks against the mainlanders prevent free movement, and fishing ventures have so far retained the identity of the islanders, and hampered the development of the islands. There are inter- Island conflicts and fishermen from one Island do not permit other Islanders to fish in their waters. The Administration may initiate massive awareness programmes among the Islanders to encourage co-operation and to eliminate Inter-Island conflicts related to fishing operation. Free fishing access in the Lakshadweep should be encouraged for all Islanders.

13.5.Policy for access to credit and financial support/special incentive

a). For any developmental programme to be successful, access to credit and financial support and incentive schemes are essential. Almost all banks in the country offer attractive financial loan schemes for fishing operations. However, the administration (particularly the Department of Fisheries) will have to maintain liaison with the banks, especially for large investments as envisaged in oceanic tuna fishing. The SCICI may also have to be involved in this process for large loans. To attract investment it is necessary to offer incentives in the initial stages. *LAKFISH* recommends that the administration consider a 20% incentive on capital costs as a first step, and later revise the rate based on the response from private investors. *LAKFISH* also recommends creation of single window agency (Fisheries Development Agency) for assisting entrepreneurs to obtain all necessary licenses, permits and clearances.

b). Credit facility may be extended to dory fishing units and combination vessels that would venture into the distant *parr*/bank areas of fishing for fishes other than tunas. The dory units need to be supported by the redundant DoF vessels (larger ones) with essential supplies.

c). For purchase of mechanical sprayers, more subsidies may be granted to the pole and line units.

d). Minimum-fishing days (90 days/year or 10 days/month during September-May) may be fixed for availing the service/credit/subsidy facilities from the department and

its workshops. The boats which are engaged in activities other than fishing or not meeting the required minimum days of fishing need to be charged the full rates without any subsidy or concessions. At the same time the boats, which are bringing higher catches may be rewarded by giving 5% more subsidy on diesel, spares, services etc.

13.6.Permission from MOE & F for collection of sea cucumber

It is recommended that the Lakshadweep Administration may approach Ministry of Environment and Forest and obtain permission to collect selected species of sea cucumber for developing broodstock, establish hatchery and grow- out system and to export products.

.....