Bay of Bengal Programme

Development of Small-Scale Fisheries

PIVOTING ENGINE INSTALLATION
FOR BEACHLANDING BOATS

BOBP/WP/44

SWEDISH INTERNATIONAL DEVELOPMENT AUTHORITY

FOOD AND AGRICULTURE ORGANISATION OF THE UNITED NATIONS

PIVOTING ENGINE INSTALLATION FOR BEACHLANDING BOATS

BOBP/WP/44

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Food and Agriculture Organization
of the United Nations

Funding Agency
Swedish International
Development Authority

Development of Small-Scale Fisheries in the Bay of Bengal. Madras, India, June 1986.
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This paper describes the efforts to develop an appropriate engine installation for boats designed and developed for fishermen in India and Sri Lanka operating from surf ridden beaches. These boats have to negotitate rough surf conditions for most part of the year with breaking waves up to two metres in height.

The paper details the different types of pivoting engine installations tried out with air-cooled and water-cooled engines of different makes. The problems faced, the improvements made and the conclusions derived are set out. It also includes a detailed description of an installation. The detailed drawings are available with BOBP and may be obtained on request.

The work on engine installations described in this paper was carried out by the small-scale fisheries project of the Bay of Bengal Programme (BOBP1 as part of its beachcraft development project. It began in 1980.

The first trials were conducted from a beach just outside Madras and were reported in BOBP/WP/7 "Technical Trials of Beachcraft Prototypes in India."

The original concept of the pivoting engine box was conceived by 0. Gulbrandsen (Naval Architect Consultant) who also designed the first prototype. Further development described in this paper was done by the authors, assisted by BOBP Associate Professional Officers P.A. Hemminghyth (Marine Engineer) and SO. Johansen (Naval Architect), counterpart officers S.B. Sarma (Andhra Pradesh), E. Srinivasan (Tamil Nadu) and G. Patrick (Colombo). G. Gowing (Surf Crossing Consultant) from Australia also contributed several useful ideas. Trials were carried out in Tamil Nadu, Andhra Pradesh and Orissa in India and Sri Lanka.

Another BOBP document of direct relevance to the subject described in this paper is BOBP/WP/45 "Further Development of Beachlanding Craft in India and Sri Lanka."

The small-scale fisheries project of the Bay of Bengal Programme is funded by SIDA (Swedish International Development Authority) and executed by FAO (Food and Agriculture Organization of the United Nations). It covers five countries bordering the Bay of Bengal --- Bangladesh, India, Malaysia, Sri Lanka and Thailand. It is a multi-disciplinary project, active in craft, gear, aquaculture, extension, information and development support. The project's main goals are to develop, demonstrate and promote appropriate technologies and methodologies to improve the conditions of small-scale fisherfolk in BOBP's member countries.

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1. INTRODUCTION

Since the introduction of the steam engine, motorization has been a prime factor in the development of fishing craft. Boats have relied less on sail, and new hull forms, specifically designed for engine power, have been developed. A fixed engine coupled to the propeller shaft emerging astern through a stern tube embedded in the keel has become the conventional design. Many small traditional boats too were motorized in this way. The development of the outboard motor solved some problems where a conventional installation was not possible.

But there has been one type of boat for which motorization has not been easy -- the boat operating from open beaches having to cross in and out through heavy surf and landing violently on the beach. Several attempts have been made by FAO and other organisations in the past to develop a powered beachlanding boat as well as to motorize traditional craft operating from the beach, namely the kattumaram and the nava. The reasons for failure related to boat size, weight and type of engine installation. Sand getting into the cooling system caused difficulties with a water cooled engine. A conventional installation without adequate protection to the propeller and rudder failed due to damage to the appendages while landing on the beach. Trials in Tamil Nadu and Andhra Pradesh in India, with outboard motors installed on kattumarams and navas, did not show much promise due to the high initial and running costs. Though damage to the propeller was avoided by lifting it, the rubber impeller of the pump was quickly destroyed by sand abrasion. As a result the fishing craft operating from such areas have remained unchanged till now and motorization has been an unfulfilled dream for beach fishermen.

2. DESIGN CONSIDERATIONS

2.1 From the lessons learnt in previous attempts, BOBP undertook the development of a new type of beachcraft (see BOBP/WP/7l. To prevent damage to the propeller, rudder and skeg, a system was required to get them out of the way easily on contact with the ground. A system exists where the propeller and part of the shaft can be lifted into a recess by fitting a universal joint on the shaft. Since sand and corrosion would destroy the universal joint, and the lifting action was not smooth enough to allow quick propeller retraction on striking ground, a better solution had to be developed.

The surf beaten beach is a harsh environment; the sand, sea spray and sun making it perhaps the most corrosive natural atmosphere anywhere. The engine had to be protected in some way.

With steadily rising fuel costs, fuel efficiency and economy also become very important considerations. Achieving this is possible in many ways; easily driven hulls, a lower operating speed and more efficient propulsion are some of the more important means. All BOBP beachcraft are characterised by sharp entry, flat runs aft and buttocks to ensure good flow of water to the propeller, making them highly fuel efficient.

In India where the traditional beachcraft are not motorized, the situation demanded low initial cost and low running costs. To achieve this and yet provide more speed than the non-motorized local boats, the solution was to use a low powered diesel engine without a gearbox or clutch, to reduce initial cost, and easily driven hulls for lower running cost. A power (hp)/displacement (tonnes) ratio of 5 was considered adequate.

In Sri Lanka where the existing fishing fleet is largely motorized, similar or better speeds at lower cost had to be achieved. This was done by using slightly higher powered engines than in India, fitting high reduction gearboxes and larger diameter propellers.

The achievements in respect of fuel efficiency are illustrated by the trial records (Table 1) of two of the boats — one in India and one in Sri Lanka. The latter is also compared with the record of a commonly used boat popularly called the 28-footer or the 3 1/2 tonner.

80BPs IND-20 craft – Propeller in 'Sup" position.

Propeller in "down" position.

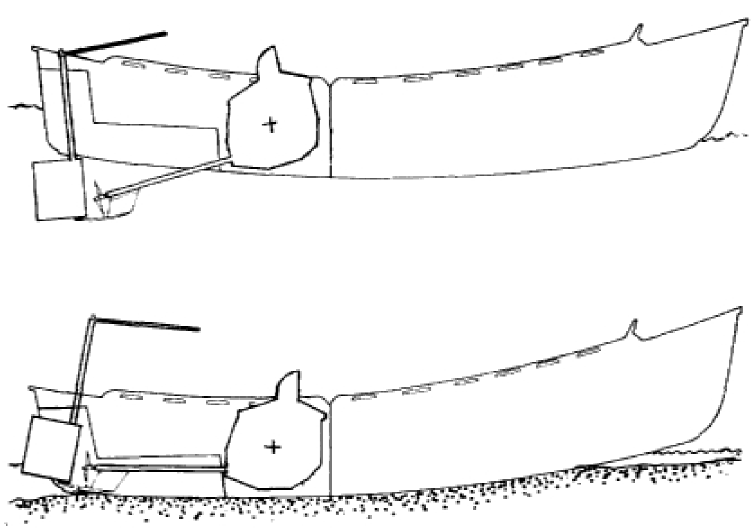
Table 1
POWER, SPEED AND FUEL CONSUMPTION

	INDIA	SRI LANKA	
	28 ft. BOBP beachcraft IND-20	28 ft. BOBP beachcraft SRL-14	Standard 28 footer
Power (hp)	8	20	30
Reduction	2	3.65	2.13
Propeller (rpm)	1450	685	1030
Max. speed (knot)	6.6	7.8	7.4
Power displacement ratio (hp/tonne)	4	5.5	8.5
Speed length ratio (V/ L)	1.36	1.52	1.50
Fuel consumption (l/hr)	2.2	5	7.7
Fuel consumption (l/n. mile)	0.33	0.64	1.10
Fuel cost (US $/n. mile)	0.09	0.23	0.40

3. PROTOTYPES

From the outset BOBP's attempt was to install the engine in a pivoting water tight box installed in a well provided in the boat. The stern tube, propeller and rudder were part of the installation. Lifting the rudder stock caused the propeller and rudder to be retracted into a recess provided in the boat. Propeller recess, the shaft tunnel and the engine well were flooded since they were open to the sea. Loss of buoyancy on account of engine box installation was taken into consideration in the hull design.

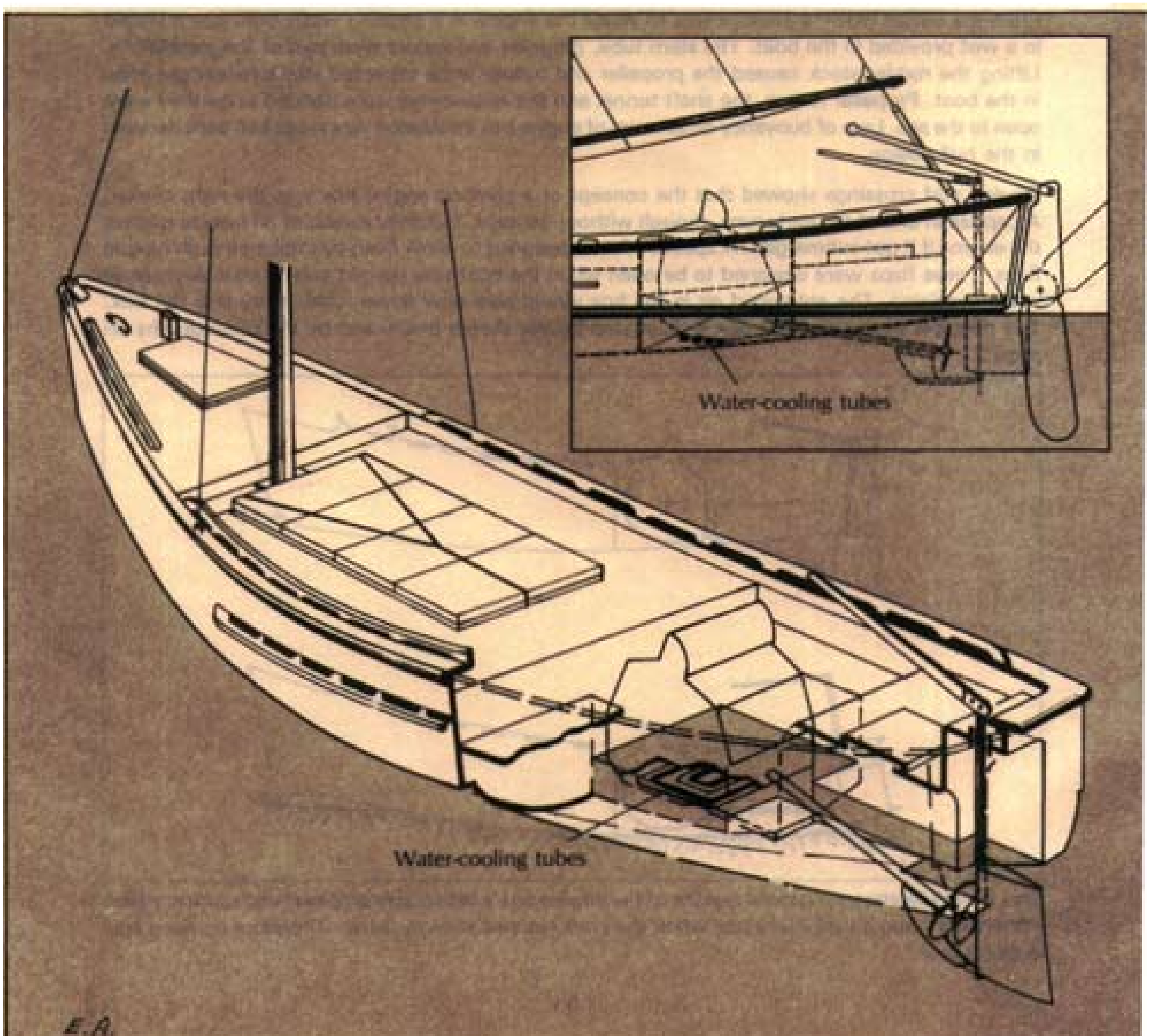
Several surf crossings showed that the concept of a pivoting engine box was the right choice. A capsize in one of the early runs, though without damage, focussed attention on how to protect the engine if it got submerged. A special lid was designed to allow fresh air intake through hinged flaps. These flaps were designed to be open when the boat was upright and to shut themselves when capsizing. The entrapped air in the box would also slow down water entry into the box. The principle of the pivoting box is illustrated by the sketch below and by the photographs on page 2.



This sketch illustrates a special feature of the engine box's retractable propeller and rudder, which "disappear" into a well in the hull when the craft reaches shallow water. Therefore no fixed keel is necessary.

Engine box with V.S.T. 8 h.p. engine (aircooled)

A perspective drawing showing the water-cooled engine installation and the position of water- cooling tubes.



Altogether six different engines, four of them air cooled, were tried out during the course of the trials. The main characteristics of the engines are given in Table 2.

Table 2

MAIN CHARACTERISTICS OF ENGINES

Boat	Engine	hp/rpm	Reduction	Cooling	Engine Weight **(Kg)**
IND-Boats	Lombardini 523	4.8./3600	2	Air	39
IND-Boats	VST-Shakti	8/3000	2	Air	112
IND-20-C	VST-Shakti	10/3000	2	Fresh water	115
SRL-11	Deutz F1L2100	12.5/3000	2.72	Air	95
SRL-12	Deutz F1L511D	14.3/2800	5.1	Air	130
SRL-14	Faryman R-30	20.0/2500	3.65	Fresh water	195

IND = Designs for India SAL = Designs for Sri Lanka

3.1. Air-cooled engines

The choice and type of diesel engine were dictated by two main considerations : weight and cooling system. Air cooled engines were preferred to water cooled ones to avoid complicated arrangements required to prevent sand entering the cooling system. The fact that the engine needs to be started prior to launching was another factor in favour of an air cooled engine. In India the choice of engine was also determined by import restrictions; any engine used had to be produced in India.

3.1.1. Lombardini 523

For the first series of beachlanding craft, the engine chosen was a Lombardini model 523, developing 4.8 hp at 3000 rpm with inbuilt 2 : 1 reduction (camshaft output). Its main advantage was low weight (only 39 kg). The installation was made as described earlier, using a pivoting plywood watertight box, an oil filled stern tube, flexibly coupled shafting and an integral rudder system.

Three boats of the IND-13 type (see BOBP/WP/26) were built as a follow up to the 1980 technical trials and put into commercial fishing operation at Uppada, Andhra Pradesh. The trials lasted 17 months, and valuable experience was gajned in many aspects of beachcraft and the engine installation. One of them was that the engine chosen was unreliable under actual operating conditions of a beach-based fishing craft. Vibration was excessive and this, combined with poor corrosion protection, caused a lot of downtime. Being a very light engine, the Lombardini 523 did not stand up to extended use. Engine boxes with Lombardini engines installed in other prototype boats in Madras (IND-il) and Kerala (IND-18) also faced the same problems. A heavier duty engine was therefore considered, even if it meant extra weight.

3.1.2. VST Shakti-Mitsubishi **AD 8**

A review of the market in India led to an alternative, an 8 hp air cooled engine (VST Shakti-Mitsubishi). Further development was undertaken using this engine for the second generation of beachcraft in India. Continuous improvements were also made to the components from time to time. A detailed description of the engine box housing this engine is described later in this paper.

3.1.3. Deutz 5112100 & 51L511D

For beachlanding craft designed for Sri Lanka, the choice of engines was wider. Engines of all makes are allowed for import as none is made locally.

A 12.5 hp air cooled diesel engine (Deutz 5112100) fitted with a reverse gearbox of 2.72 reduction was installed in the first prototype craft SR L-11. This boat operated for over two years but frequent problems of overheating were a matter of concern. It was felt that circulation and supply of air was inadequate due to size limitations of the engine box.

A 14.3 hp engine (Deutz 51L511D) fitted with a 5.1 reduction gear was installed in two craft of the next prototype (SRL-12) in Sri Lanka. These craft were to be tried out as trawlers which was the reason for installing such an extreme reduction gear. These engines too suffered from overheating especially during heavy trawling duty.

3.2. Water cooled engines

Problems of overheating of the larger aircooled engine in a small box, which occurred in the Sri Lanka boats, prompted trials with a water cooled engine. A worldwide survey of suitable light-weight engines was made.

3.2.1. Faryman R30

The Faryman R30 developing 20 hp was chosen for a beachianding craft in Sri Lanka (SRL-14). The fresh water used for cooling was circulated in copper pipes attached to the underside of the box. These pipes, in contact with sea water in the well, cooled the circulating fresh water by heat transfer, similar to the keel cooling principle found in many boats using a water-cooled engine. Trials proved that overheating was no longer a problem.

A disadvantage is the slightly higher weight – which is fully compensated for by more reliable performance.

3.2.2. VST-Shakti-Mitsubishi AD1O

Trouble-free operation of the water-cooled engine in Sri Lanka for over a year prompted the testing of a similar solution for BLC in India. The manufacturer of the air-cooled engine offered for trial a 10 hp water-cooled engine. An engine box was constructed, similar to the Sri Lanka version, and installed in the latest version (C) of the IND 20. The use of a 2 : 1 gearbox and a larger propeller than for the air-cooled version showed a considerable increase in speed (from 6.6 knots to 7.5 knots). Initial trials have been encouraging.

4. MAJOR ENGINEERING FEATURES

The Appendix provides a record of the development of the engine box using the VST 8 hp air-cooled engine. Most of it is also applicable to other engines tried out by the project. The most important features are

(1) A grease filled stern tube with a grease retainer ring fitted on the propeller to prevent grease from coming out, thus minimizing the shaft wear due to sand abrasion.
(2) Additionally, a replaceable stainless steel shaft liner is fitted in way of the stern bearing.
(3) A special rudder heel fitting permitting free turning and pivoting of the rudder.
(4) Stainless steel fittings and fasteners in corrosion prone areas.
(5) A flexible stuffing box.
(6) Rigid flange coupling (engine/shaft).
(7) An air inlet flap to shut off combustion air to stop the engine in case of a capsize.
(8) FRP cover over exposed mild steel fittings.
(9) Grease lubricated cast iron pivot housings.

Please refer to the pivoting engine installation drawing (Page 11).

5. INSTALLATION DESCRIPTION

Given below is a detailed description of the various engine box components. The VST 8 hp air-cooled engine is essentially an engine developed for tractor-tillers. To make it suitable for marine use the following modifications were carried out in close cooperation with the engine manufacturer.

1. Made combined throttle and stop control.
2. Fitted chrome sleeve on the engine output shaft to protect the oil seal. A rusting shaft was destroying the seals quickly.
3. Fitted tapered output shaft to take a flanged half coupling.
4. Raised the oil filling pipe and modified the dipstick cover to an overlapping cap with female threads. This was done to prevent sand from falling in when filling oil or checking oil level.

5. Fitted a new air intake elbow on the engine to permit easier connection of the air cleaner to the air inlet flap.
6. Provided propeller thrust bearing internally.
7. Fitted raised engine brackets.
8. Fitted a rope start pulley to the flywheel.
9. Relocated lubricating oil filter to limit engine width.
10. Made an external fuel tank of 20 litre capacity.
11. Provided a water separator in addition to fuel filter.
12. Used brass fuel fittings and heat-resistant hydraulic hose for fuel.

Several engine box installations were made, incorporating these modifications and new ideas from time to time. What follows is a description of the latest box installation.

1. **Box** : The box to house the engine is assembled from 12 mm marine plywood, battens, screws and glue. It is shaped to fit inside the well provided in the boat with necessary clearances from the hull bottom, engine well sides and bulkheads in the up/down positions. A partition bulkhead of 9 mm marine plywood is provided to separate the hot air from the intake air.

2. Lid : It is built of wooden sides held together with steel tie rods and with hinged plywood covers for ventilation and general access. An air scoop coaming is provided at the top. Provision has been made for water drainage and for a water trap. Hinges for the covers are of leather.

3. Scoop : A wooden air scoop is secured to the lid with rope. It can be placed facing either forward or aft.

4. Chassis : Fabricated from mild steel, this assembly includes the base for the engine welded to a plate which supports the forward end of the sterntube. The main base is of 75 x 40 x 6 mm mild steel channel, welded to a 6 mm face plate. The assembly is bolted to the box sides and aft face. Wooden filler pieces are glued to the inside of the channel. The mild steel stern tube is welded on to the face plate with a projection inboard for connecting the flexible stuffing box and also to provide a grease filling point. A stainless steel flat bar flange is welded to the aft end of the sterntube for bolting the skeg and spoon. The face plate is suitably stiffened with mild steel gussets welded to the sterntube and channels. The outboard end of the sterntube is machined and fitted with a stainless steel liner to take the bronze stern bush.

5. Stern **Bush** : It is a machined bronze casting with a collar outboard to take the grease retainer ring. It is held in place by a 3/8" BSW stainless steel lock bolt which is subsequently locked by a stainless steel flat welded to the tube. The bronze grease retainer ring is held to the propeller shaft by an extended propeller key.

6. Pivots : Pivot plates of mild steel are bolted to the box sides through the engine base. Pivot shafts are welded to these plates and are provided with stainless steel liners. These shafts are drilled and grooved for grease lubrication. Pivot housings of cast iron are bolted to a heavy longitudinal member on the engine well side. These housings are internally grooved for grease lubrication. Grease also prevents sand entry.

7. Exhaust System : All exhaust piping is of 16 gauge stainless steel. The assembly is in two sections to facilitate engine removal. The exhaust pipe is taken out through the aft face of the box and down to the stern tube gussets. Holes of 3/8" dia are drilled to let the exhaust gases escape above the waterline and out through the shaft tunnel. Engine exhaust flange bolts are lengthened using spacers to avoid loosening due to vibration.

8. **Air Inlet Flap** : **A** specially designed gravity activated flap mechanism, which shuts off combustion air to the engine when capsizing is fixed to the partition bulkhead. The spring loaded catch and the hinge are of stainless steel. A flexible rubber hose connects it to the air filter.

9. Engine Control : Throttle and stop control are incorporated into a single stainless steel fitting. All linkage is off stainless steel rod. The fitting comprises a friction band around a pipe. A screwed lever enables tightening of the band and the throttle can be set at any position. This assembly is bolted to the aft face of the box within easy reach of the helmsman.

10. Fuel System : A mild steel fuel tank of 20 litre capacity is bolted to the engine box side, externally. All fuel piping should be of heat resistant neoprene and hydraulic grade as a lot of heat is generated inside the box with an air cooled engine. In addition to a fuel filter, a water separator is also fitted.

11. **Skeg & Spoon** : The skeg is fabricated in mild steel and is bolted to the stainless steel flange welded to the sterntube. A spoon-shaped mild steel plate is welded to the skeg. This spoon protects the propeller while grounding and its shape permits it to skid over the ground rather than dig into the sand.

12. **Rudder** : **A** stainless steel pipe rudder stock is welded to a mild steel profile framework. This framework is bonded to the two halves of the hollow rudder blade. The blade is sealed at top and bottom. It is airfoil-shaped and moulded in FRP using a split mould. A sacrificial stainless steel pipe is inserted into the main rudder stock and extends up to the tiller. In case of damage after a capsize, only this pipe needs to be straightened or replaced.

In order to reduce cost and facilitate easy replacement, the FRP blade has been replaced by a solid wooden blade in two parts, glued and covered over with FRP with the rudder stock embedded inside.

13. **Heel Fitting** : Stainless steel half links permit the rudder to swivel universally. One link is welded to the spoon and the other to the lower end of the rudder stock pipe.

14. Protection

(1) Stainless steel and bronze are used for all exposed fittings. Please refer material schedules on drawings.

(2) Mild steel fittings inside the box are protected with anti-corrosive paints.

(3) FRP cover is used to cover the engine box, fuel tank and sterntube.

15. FRP Layup : Steel parts should be degreased and plywood components well roughened. See drawings for areas covered with FRP.

LAYUP

Box outside	*Sterntube*	*Fuel Tank*
1. 2 layers of 600 g/sq m on all corners	1. 2 layers of 600 g/sq m	1. 2 layers of 600 g/sq m
2. 2 layers of 450 g/sq m over the box sides and bottom	2. 1 layer of surface tissue	2. 1 layer of surface tissue
3. Resin top coat	3. Resin top coat	3. Resin top coat

6. DISCUSSION

No major changes may be needed for engine boxes using the VST 8 hp air-cooled engine and the Faryman R 30, 20 hp engine for the Indian and Sri Lankan beachboats respectively. To adapt this installation to other makes of engines, the following considerations are of importance.

(a) Engine weight should be kept as low as possible.

(b) Rope start of the engine without using the decompression lever. A raised hand crank start is acceptable provided care is taken in modifying the lid.

(c) Flexible hoses should be heat and oil resistant.

(dl Components for throttle control should be of non-corrosive material.

The pivoting engine box requires a well and a shaft/propeller recess to be provided in the boat. This can easily be achieved in new boat designs of plywood, FRP, or aluminium but great care is needed in conventionally constructed planked boats to avoid flooding. Though the loss of buoyancy due to the open engine well can be minimised by close tolerances with the box dimensions, it is a factor that must not be overlooked

Increase in cost over a conventional installation is marginal. The extra cost involved is for the plywood box, the pivot assembly and the safety flap for quick air shut-off in case of a capsize. This is assuming that the transmission, stern-tube, and rudder are of the same size and material in both installations. This can easily be recovered in a beachlanding boat due to an increase in number of fishing days. We have estimated that for the VST 8 hp engine box, the increase in cost is approximately U.S. $ 500 when compared to the conventional installation.

The ability to retract the propeller and rudder is a feature equally useful for shallow draft boats. In addition, this feature is useful in reducing propeller drag while sailing. There is no need of a clutch either as the propeller can be retracted into the hull with the engine running.

Very often there are no repair facilities in remote fishing villages. Having a spare engine box will mean no 'down-time' as it can be easily installed like a cassette while the sick unit s taken for repairs.

The main reasons for the success of such an installation in beachlanding boats are the availability of light diesel engines today and the keen development efforts made possible by an extended programme for beachcraft development involving a great deal of time and money. We hope the advantages gained by this system will lead to further development in the use of diesel engines for beachlanding craft.

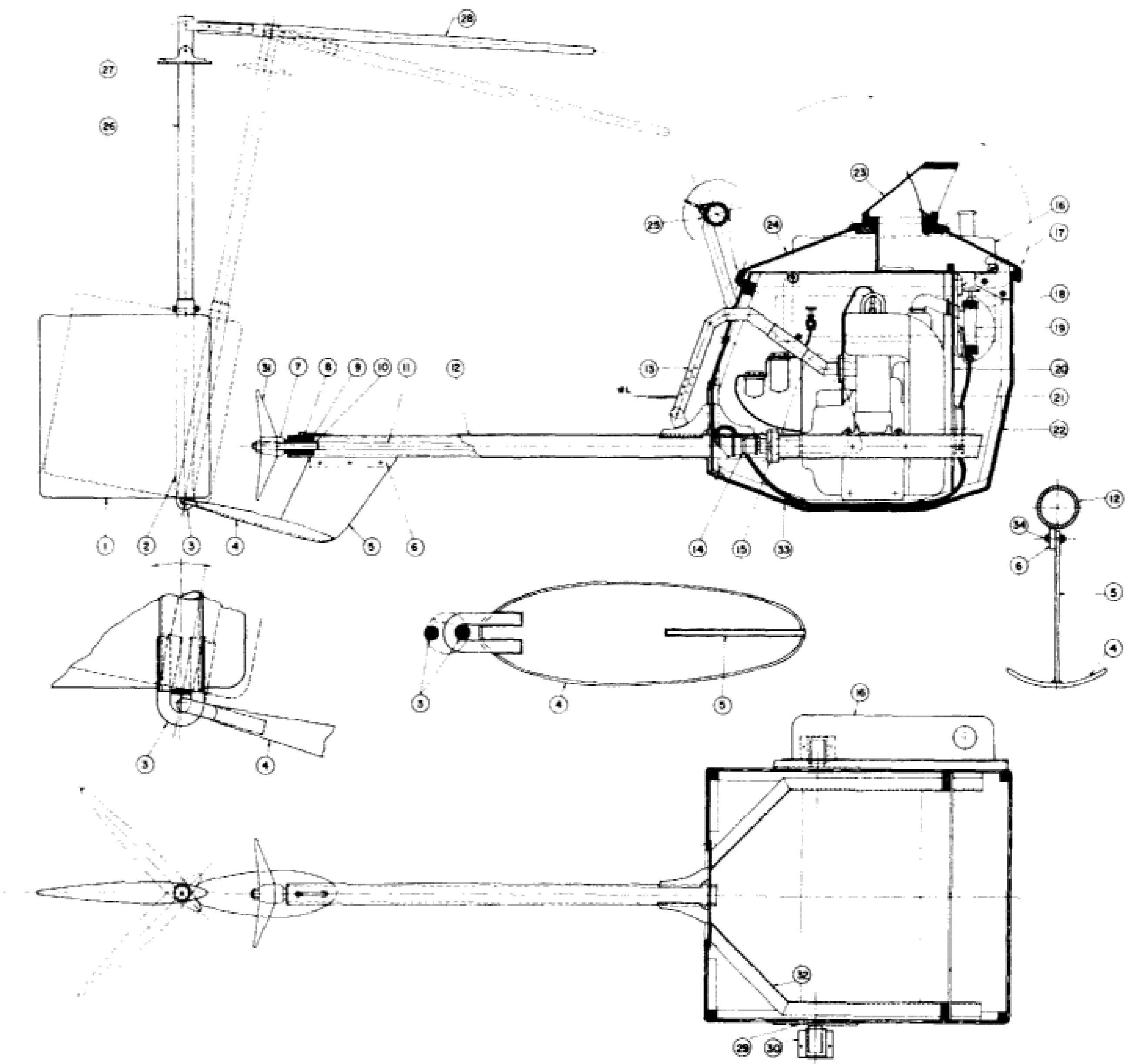
Appendix

DEVELOPMENT RECORD

No.	*Problem*	*Intermediate solutions/ reasons for failure*	*Final solution*
01	Wear on shaft, bearings and stuffing box due to sand abrasion.	1. Oil filled sterntube with oil seals on both ends. No stuffing box. The oil seals were destroyed by sand and oil ran out. 2. No stuffing box. Bearings of hardwood, nylon and teflon were tried with a grease filled sterntube. All failed due to sand abrasion. 3. Flexible stuffing box with grease packing, grease filled sterntube and fluted rubber stern bearing was tried. Failed due to sand abrasion. Sand washed forward along the sterntube in the propeller 'up' position and destroyed the gland. Also running the engine on the beach prior to launching destroyed the fluted rubber bearing due to lack of lubrication. Remember this installation has no clutch.	Flexible stuffing box with a bronze stern bearing incorporating a grease retainer ring is used with the sterntube completely grease filled. The propeller shaft was made of AISI 304 alloy and a replaceable stainless sleeve of AISI 316 alloy fitted in way of the sternbearing. With proper daily greasing (till it comes out at the aft end), this system works well. Grease also protects the inside of the mild steel sterntube from corrosion.

02 Engine/propeller	1. Various flexible couplings available locally were tried. None lasted long enough and replacement rubber components were not easily available. 2. Since no reverse is used, a screw type coupling was tried. The propeller shaft screwed on to a boss fixed to the engine output shaft. This method failed as the threads stripped besides problems of engine alignment. 3. Tried a tapered coupling keyed to the propeller shaft and a split coupling on the engine shaft. Split coupling failed due to poor machining tolerances.	A rigid flange coupling is now in use. The engine manufacturer provided a new output shaft tapered for the half coupling. Higher cost has to be accepted.
03 Corrosion of sterntube and skeg made of mild steel to limit cost	Tried various paint systems. None lasted very long.	Covered parts with FRP. (See page 8, section on FRP layup). Works well but needs occasional attendance due to abrasion.
04 Wear of engine box pivots	Tried hardwood pivot housing with a PVC sleeved mild steel pivot shaft. Failed due to sand abrasion.	Made housing of cast iron and fitted stainless steel sleeve on pivot shaft. Provided ease lubrication to the pivots.
05 Breaking of rudder stock when boat capsizes.		Sacrificial pipe between rudder blade and tiller fitting ensures quick repairs.
06 Rudder heel fitting	Tried various solutions. This joint must allow the rudder to turn as well as pivot.	Two half links of stainless steel; one welded to the spoon and the other to the lower rudder stock (see parts 3,. 4, 5 in the pivoting engine installation drawing)
07 Engine box lid must protect the engine if a wave breaks on the boat while going through the surf. It should allow adequate fresh air intake and separate hot air exhaust. Must be strong to ensure being thrown about on deck and be securely attached to box when going out through the surf.	Tried a lid with flaps to minimize water entry into the box. Air supply and ventilation were inadequate and the lid was too heavy.	Made the lid simpler with large hinged covers for hot air outlet and cool air inlet. Also provided a turnable air scoop to face either forward or aft. Provided a water trap with drain.
08 Hydraulic compression if engine is submerged while running.		Fitted a combustion air inlet flap inside the box. While capsizing, the flap shuts off combustion air intake, thereby stopping the engine.
09 Black smoke and overheating		Propeller designed to absorb only 80% of SHP.

PIVOTING ENGINE INSTALLATION



NO	ITEM	MATERIAL
34	BOLT & NUT	S.S
33	FRP SHEATING	FRP
32	ENGINE BASE	M.S
31	PROPELLER	MN. BRONZE
30	PIVOT HOUSING	CAST IRON
29	PIVOT	M.S
28	TILLER	HARD WOOD
27	UPPER RUDDER STOCK SUPPORT	ALUMINIUM
26	REPLACEABLE RUDDER STOCK	S.S
25	THROTTLE CONTROL	S.S
24	ENGINE LID	MAR.PLYWOOD
23	AIR INTAKE SCOPE	MAR.PLYWOOD
22	ENGINE BOX	MAR.PLYWOOD
21	COOL AIR INLET	——
20	PARTITION BULKHEAD	MAR.PLYWOOD
19	STERN GREASER	C.I., M.S.
18	COMBUSTION AIR INTAKE	——
17	AIR INLET FLAP	S.S, BRONZE, M.S
16	FUEL TANK	M.S.
15	COUPLING	EN 8 STEEL
14	STUFFING BOX	BRONZE
13	EXHAUST PIPE	S.S. 16 G
12	STERN TUBE	SEAMLESS M.S
11	SHAFT	S.S AISI 304
10	SHAFT LINER	S.S AISI 316
9	STERN TUBE LINER	S.S AISI 304
8	STERN BUSH	BRONZE
7	GREASE RETAINER RING	BRONZE
6	FLANGE	S.S.
5	SKEG	M.S.
4	SPOON	M.S.
3	RUDDER HEEL FITTING	S.S.
2	RUDDER STOCK	S.S.
1	RUDDER BLADE	FRP

PIVOTING ENGINE INSTALLATION

ASSEMBLY - VST 8hp AIR COOLED ENG.

SCALE : 1-8, 1-25	BOAT NO.	DRG. NO.
DESIGN : A. OVERA		1
DRAWN : V. SURESH		

Publications of the Bay of Bengal Programme (BOBP)

The BOBP brings Out SIX types of publications

Reports IBOBP/REP! I describe and analyze completed activities such as seminars, annual meetings of BOBP's Advisory Committee, and projects in member-countries for which BOBP inputs have ended.

Working Papers IBO8P/WP/ I are progress reports that discuss the findings of ongoing BOBP work.

Manuals and Guides IBOBP/MAG/) are instructional documents for specific audiences.

Miscellaneous Papers IBOBP/MIS .1 concern work not originated by BOBP staff or consultants but which is relevant to the Programmes objectives.

Information Documents (BOBP/INF/.. I are bibliographies and descriptive documents on the fisheries of member-countries in the region.

Newsletters (Bay of Bengal News), issued quarterly, contain illustrated articles and features in non-technical style on BOBP work and related subjects.

A list of publications follows.

Reports (BOBP/REP, ...)

1 Report of the First Meeting of the Advisory Committee. colombo, Sri Lanka, 28-29 October 1976. lPublished as Appendix 1 of IOFC/DEV/78/44.1, FAO, Rome. 19781

2. Report of the Second Meeting nf the Advisory Committee. Madras, India, 29-30 June 1977. (Published as Appendix 2 of IOFC/DEV/78/44.1, FAO, Rome, 1978)

3. Report of the Third Meeting of the Advisory Committee. Chittagong, Bangladesh, 1-10 November 1978. Colombo, Sri Lanka, 1978. (Reissued Madras, India, September 19801

4. Role of Women in Small-Scale Fisheries of the Bay of Bengal. Madras, India, October 1980.

5. Report of the Workshop on Social Feasibility in Small-Scale Fisheries Development. Madras, India, 3-8 September 1979. Madras, India, April 1980.

6. Report of the Workshop on Extension Service Requirements in Small-Scale Fisheries. Colombo, Sri Lanka, 812 October 1979. Madras, India, June 1980.

7. Report of the Fourth Meeting of the Advisnry Committee. Phuket, Thailand, 27 30 November 1979. Madras, India, February 1980.

8. Pre-Feasibility Study of a Floating Fish Receiving and Distribution Unit for Dubla Char, Bangladesh. G. Eddie, M. T. Nathan. Madras, India, April 1980.

9. Report of the Training Course for Fish Marketing Personnel of Tamil Nadu. Madras, India 3-14 December 1979. Madras, India, September 1980.

10.1 Report of the Consultation on Stock Assessment for Small-Scale Fisheries in the Bay of Bengal. Chittagong, Bangladesh, 16-21 June 1980. Volume 1 Proceedings. Madras, India, September 1980.

10.2 Report of the Consultation of Stock Assessment for Small-Scale Fisheries in the Bay of Bengal. Chittagong, Bangladesh, 16-21 June 1980. Volume 2 : Papers. Madras, India, October 1980.

11. Report of the Fifth Meeting of the Advisory Committee. Penang, Malaysia, 4-7 November 1980. Madras, India, January 1981.

12. Report of the Training Course for Fish Marketing Personnel of Andhra Pradesh. Hyderabad, India, 11-26 November 1980. Madras, India, September 1981.

13. Report of the Sixth Meeting of the Advisory Committee. Colombo, Sri Lanka, 1-5 December 1981. Madras, India, February 1982.

14. Report of the First Phase of the 'Aquacultllre Demonstration for Small-Scale Fisheries Development Project' in Phang Nga Province, Thailand. Madras, India, March 1982.

15. Report of the Consultation-cum-Workshop on Development of Activities for Improvement of Coastal Fishing Families. Dacca, Bangladesh, October 27-November 6, 1981. Madras, India, May 1982.

16. Report of the Seventh Meeting of the Advisory Committee. New Delhi, India, January 17-21, 1983. Madras, India, March 1983.

17. Report of Investigations to Improve the Kattumaram of India's East Coast. Madras, India, July 1984.

18. Motorization of Country Craft, Bangladesh. Madras. India, July 1984.

19. Report of the Eighth Meeting of the Advisory Committee. Dhaka, Bangladesh, January 16 19, 1984. Madras, India, May 1984.

20. Coastal Aquaculture Project for Shrimp and Finfish in Ban Merbok, Kedah, Malaysia. Madras, India, December 1984.

21. Income-Earning Activities for Women from Fishing Communities in Sri Lanka. Edeltraud Drewes. Madras, India, September 1985.

22. Report of the Ninth Meeting of the Advisory Committee. Bangkok, Thailand, February 25-26, 1985. Madras, India, May 1985.

23. Summary Report of BOBP Fishing Trials .Ifld Demersal Resource Studies in Sri Lanka. Madras, India, March 1986.

24. Fisherwomen's Activities in Bangladesh A Participatory Approach to Development. Patchanee Natpracha. Madras, India, May 1986.

25. Attempts to Stimulate Development Activities in Fishing Communities of Adirampattinarn, India. Patchanee Natpracha, V.L.C Pietersz. Madras, India, May 1986.

26. Report of the Tenth Meeting of the Advisory Committee, Male, Maldives, 17 18 February 1986. Madras, India, April 1986.

27. Small-Scale Aquaculture Development Project in South Thailand Results and Impact. E. Drewes, Madras, India, May 1986.

28. Activating Fisherwomen for Development through Trained Link Workers in Tamil Nadu, India Edeltraud Drewes. Madras, India, May 1986,

29. Towards Shared Learning An Approach to Nonformal Adult Education for Marine Fisherfolk of Tamil Nadu, India. L. S. Saraswathi and Patchanee Natpracha In preparation)

30. Summary Report of Trials with Large-Mesh Driftnets in Bangladesh. Madras, India, May 1986.

Working Papers (BOBP- WP ..

1. Investment Reduction and Increase in Service Life of Kattumaram Logs. R. Balan. Madras, India, February 1980.

2. Inventory of Kattumarams and their Fishing Gear in Andhra Pradesh and Tamil Nadu. T. R. Menon. Madras, India, October 1980.

3. Improvement of Large Mesh Driftnets for Small-Scale Fisheries in Sri Lanka. G. Pajot. Madras, India, June 1980.

4 Inboard Motorisation of Small G.R.P. Boats in Sri Lanka. Madras, India, September 1980.

5 Improvement of Large Mesh Driftnets for Small Scale Fisheries in Bangladesh. G. Pajot. Madras, India, September 1980.

6. Fishing Trials with Bottom-Set Longlines in Sri Lanka. G. Pajot, K. 1. Weerasooriya. Madras, India, September 1980.

7. Technical Trials of Beachcraft Prototypes in India. O. Gulbrandsen, G. P. Gowing, R. Ravikumar. Madras, India, October 1980.

8. Current Knowledge of Fisheries Resources in the Shelf Area of the Bay of Bengal. B. T. Antony Raja. Madras, India. September 1980.

9. Boatbuilding Materials for Small-Scale Fisheiins in India, Madras, India, October 1980.

10 Fishing Trials with High-Opening Bottom Trawls in Tamil Nadu, India G. Pajot, John Crockett. Madras, India, October 1980.

11. The Possibilities for Technical Cooperation between Developing Countries (TCDCI in Fisheries E. H. Nichols. Madras, India, August 1981.

12. Trials in Bangladesh of Large-Mesh Driftnets of Light Construction. G. Pajot, T. K. Das. Madras, India, October 1981.

13. Trials of Two-Boat Bottom Trawling in Bangladesh. G Pajot, J. Crockett. Madras, India, October 1981.

14. Three Fishing Villages in Tamil Nadu. Edeltraud Drewes. Madras, India, February 1982.

15. Pilot Survey of Driftnet Fisheries in Bangladesh. M. Bergstrom. Madras, India, May 1982

16. Further Trials with Bottom Longlines in Sri Lanka. Madras, India July 1982.

17. Exploration of the Possibilities of Coastal Aquaculture Development in Andhra Pradesh Soleh Samsi, Sihar Siregar and Martono Madras, India, August 1982.

18. Review of Brackishwater Aquaculture Development in Tamil Nadu. Kasemsant Chalayondeja and Anant Saraya. Madras, India, September 1982.

19. Coastal Village Development in Four Fishinq Communities of Adirampattinam, Tamil Nadu, India. F. W. Blase Madras, India, December 1982.

20. Further Trials of Mechanized Trawling for Food Fish in Tamil Nadu. G. Pajot, J. Crockett. S. Pandurangan, P. V. Ramamoorthy. Madras, India, December 1982

21. Improved Deck Machinery and Layout for Small Coastal Trawlers. G. Pajot. J. Crockett, S. Pandurangan and P. V. Ramamoorthy. Madras, India, June 1983.

22. The Impact of Management Training on the Performance of Marketing Officers in State Fisheries Corporations. U. Tietze. Madras, India, June 1983.

23 Review of Experiences with and Present Knwledge about Fish Aggregating Devices. M Bergstrom. Madras, India, November 1983.

24. Traditional Marine Fishing Craft and Gear of Orissa P. Mohapatra. Madras, India, April 1986.

25. Fishing Craft Development in Kerala Evaluation Report. O Gulbrandsen. Madras, India, June 1984.

26. Commercial Evaluation of IND-13 Beachcraft at Uppada, India. P Ravikumar. Madras, India, June 1984.

27. Reducing Fuel Costs of Fishing Boats in Sri Lanka. (In preparation)

28. Fishing Trials with Small-Mesh Driftnets in Bangladesh.
G. Paint and T. K. Das, Madras, India, March 1984.

29 Artisanal Marine Fisheries of Orissa : a Techno- Demographic Study.
M. H. Kalavathy and U. Tietze. Madras, India, December 1984.

30. Mackerels in the Malacca Straits. Colombo, Sri Lanka, February 1985.

31. Tuna Fishery in the EEZs of India, Maldives and Sri Lanka. Colombo, Sri Lanka, February 1985

32. Pen Culture of Shrimp in the Backwaters of Killai, Tamil Nadu A Study of Techno-economic and Social Feasibility.
Rathindra Nath Roy. Madras, India, January 1985.

33. Factors that Influence the Role and Status of Fisherwomen, Karuna Anbarasan.
Madras, India, April 1985.

34. Pilot Survey of Set Bagnet Fisheries of Bangladesh. Abul Kashem. Madras, India, August 1985.

35. Pen Culture of Shrimp in the Backwaters of Killai, Tamil Nadu. M. Karim and S. Victor Chandra Bose.
Madras, India, May 1985.

36. Marine Fishery Resources of the Bay of Bengal. K. Sivasubramaniam.
Colombo, Sri Lanka, October 1985.

37. A Review of the Biology and Fisheries of *Hrlsa Ilisha* in the Upper Bay of Bengal. B T. Antony Raja.
Colombo, Sri Lanka, October 1985.

38. Credit for Fisherfolk : The Adirampattinam Experience. R. S. Anbarasan and Ossie Fernandez
Madras, India, March 1986.

39. The Organization of Fish Marketing in Madras Fishing Harbour. M. H. Kalavathy.
Madras, India, September 1985.

40. Promotion of Bottom Set Longlining in Sri Lanka.
K. 1. Weerasooriya, S. S. C. Pieris, M. Fonseka. Madras, India, August 1985.

41 The Demersal Fisheries of Sri Lanka. K. Sivasubramaniam and R. Maldeniya.
Madras, India, December 1985.

42. Fish Trap Trials in Sri Lanka. (Based on the report of Ted Hammermanl.
Madras, India, January 1986.

43. Demonstration of Simple Hatchery Technology for Prawns in Sri Lanka. Madras, India, June 1986.

44. Pivoting Engine Installation for Beachlanding Boats. A. Overa, R. Ravikumar. Madras, India, June 1986.

Manuals and Guides (BOBP/MAG,.

1. Towards Shared Learning Non-formal Adult Education for Marine Fisherfolk. Trainers' Manual.
Madras, India, June 1985.

2. Towards Shared Learning Non-formal Adult Education for Marine Fisherfolk, Animator's Guide.
Madras, India, June 1985.

3. Fishery Statistics on the Micro-computer A BASIC version of Hasselblad's NORMSEP Program.
Colombo, Sri Lanka, June 1986.

Miscellaneous Papers (BOBP,.'M!S/.

1. Fishermen's Cooperatives in Kerala A Critique. John Kurien. Madras, India, October 1980.

2. Consultation on Social Feasibility of Coastal Aquaculture.
Madras, India, 26 November-i December 1984. Madras, India, November 1985.

Information Documents (BOBP 'INF..

1. Women and Rural Development in the Bay of Bengal Region Information Sources.
Madras, India, February 1982.

2. Fish Aggregation Devices : Information Sources. Madras, India, February 1982.

3. Marine Small-Scale Fisheries of India : A General Description. Madras, India, March 1983.

4, Marine Small-Scale Fisheries of Andhra Pradesh A General Description. Madras, India, June 1983.

5. Marine Small Scale Fisheries of Tamil Nadu A General Description. Madras, India, December 1983

6 Marien Small-Scale Fisheries of Sri Lanka A General Description. Madras, India, November 1984.

7. Marine Small-Scale Fisheries of Orissa : A General Description. Madras, India, December 1984.

8 Marine Small-Scale Fisheries of Bangladesh : A General Description. Madras, India, September 1985.

9 Food and Nutrition Status of Small-Scale Fisherfolk in India's East Coast States : A Desk Review and Resources Investigation. V Shavani. Madras, India, April 1986.

Newsletters (Bay of Bengal News)

21 Issues quarterly from January 1981 to March 1986.

Published by the Bay of Bengal Programme, FAO, 91, St. Mary's Road, Abhirarnapuram, Madras-600 018, India.
Printed at Nagaraj & Co., Madras-600 041.