Bay of Bengal Programme

Small-Scale Fisherfolk Communities

DEVELOPMENT OF OUTRIGGER CANOES IN SRI LANKA

BOBP/WP/61
(REVISED)

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BAY OF BENGAL PROGRAMME BOBP/WP/61 (Revised)

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DEVELOPMENT OF OUTRIGGER CANOES IN SRI LANKA

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Small-Scale Fisherfolk Communities in the Bay of Bengal.
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This paper discusses the role of outrigger canoes, traditional and modern, in Sri Lanka's fisheries, and their future in the context of the availability of boatbuilding materials. It also discusses the aims and design features of new canoes developed and demonstrated in Sri Lanka with the assistance of BOBP, the Bay of Bengal Programme for Fisheries Development, and the performance of these canoes during trials in Negombo and Dodanduwa in southern Sri Lanka. Some suggestions have been made for future development.

The development work with new outrigger canoes, including the trials, was carried out in co-operation with private fishermen and boatyards.

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1. INTRODUCTION

Sri Lanka has about *25,000* fishing craft. Some 15,000 of them are of the traditional type, but some (about 2,800) have been motorized. In spite of the large increase in the number of "modern" craft, statistics indicate that the number of traditional craft has not significantly decreased over the last 20 years.
Of a total of 70,000 fishermen, about half are using motorized and non-motorized traditional craft, producing 30-40% of the total marine landings.

The main reasons why the traditional craft have maintained a strong position are

- Low investment
- Can be beach landed
- Lack of other employment possibilities for fishermen

Many fishermen have difficulties in obtaining bank finance for a "modern" boat and have to depend on informal credit from within the village. Although the interest charged on this credit is high, the investment level on traditional craft is low enough to make it sustainable.

There are four major types of traditional craft. Their principal features and distribution along the coast of Sri Lanka are given in Appendix 1. The approximate numbers are given in the table below:

No. of traditional craft (1986)	Non-motorized	Motorized
Outrigger canoes (Oru, Kulla, Thony)	4,400	700
Other planked craft and dugout canoes (Vallam)	3,600	700
Log rafts (Kattumaram, Teppam)	3,900	1,400
Beach seine craft (Padahu, Pathai, Paru)	400	–
Total	12,300	2,800

Over the last 30 years, several new types of craft have been introduced. Most of them have been sold through Government schemes with subsidies for boat and engine.

No. of "modern" craft (1986)

17 -18 ft FRP boat with 7-12 hp outboard engine (18 footer)	7,200
3 1/2 - 5 ton boat with 25 - 35 hp inboard diesel engine (3 1/2 tonner)	2,700
10 - 16 ton boat with 50 - 60 hp inboard diesel engine	100

In 1983, a costs and earnings study of fishing boats and fishing methods was carried out in Hambantota district (Vassdal 1984). The study covered non-motorized and motorized Orus, 18 footers with outboard engines and 3 1/2 tonners. The economic analysis concluded that

> "Only the Orus showed a profit, all the other groups reported losses without subsidies".
>
> "The owner and the crew on the modern boats have a feeling they are fishing on a very profitable boat, but this is due to (1) subsidies and (2) not withholding enough profit to be able to reinvest in a similar boat without continued Government financial support".

This conclusion may not be valid for all of Sri Lanka, but it indicates to what extent the development of the "modern" sector has been assisted by generous subsidies.

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Of the traditional craft, the Oru offers significant advantages with regard to propulsion. Because of a long and narrow hull the power required to attain a certain speed is relatively low; a large sail area can be carried because of the good stability provided for by the outrigger. An improved Oru would therefore probably be able to compete with "modern" craft on equal terms, i.e. if they were both subsidized to the same degree — or not subsidized at all, which might be a more likely future scenario.

But the Oru has a major disadvantage. The main hull is hollowed out from a single log. The log therefore has to be straight and of sufficient girth and length to fit the canoe. On account of deforestation, it is increasingly difficult to find suitable logs. Often logs are felled without Government permit. The hollowing out of a log to make a dugout leads to wastage of timber. If the same log was sawn into planks one could make between two and three planked canoes.

Over the last 40 years, the Government has undertaken large-scale forest plantation schemes. Today, 80% of the timber comes from natural forests. By the year 2000, only about 35% of the timber will come from natural forests and this will be further reduced to 6¾after 2020 (Forestry Master Plan for Sri Lanka 1986). The plantation species, mostly teak and eucalyptus, are either too expensive or unsuitable for making dugout canoes. Although logs for making smaller dugout canoes are still available, forest development will in the future force Oru fishermen to find alternative methods of building their canoes.

Considering the widespread use of Orus, their attractive speed/power features as well as the wasteful construction method, BOBP set out to develop alternative designs. The work has been in progress, interjnittently, since 1979.

In the first phase, the strategy was not to improve the Oru but to find other solutions maintaining the advantages of the Oru; a catamaran (twin hull) and a trimaran were tested.

In the second phase, the strategy was to improve on the existing Orus. It was a result of the disappointing outcome of the trials of the catamaran and the trimaran. The work focussed on the larger Orus (in Negombo) since they were likely to be the first ones to suffer from shortage of logs.

The third phase which was concluded in 1989 aimed at developing an outrigger canoe of the most common size (7-9m) that would also be able to compete with the 18-footers.

2. THE ORU

Advantages of the outrigger concept

The Oru is a single outrigger craft of a type that can be found from Madagascar in the west to Indonesia, and the Pacific Islands in the east. Compared with a monohull the outrigger canoe has the following advantages (at the same cost)

- Higher speed because of a longer and narrower hull.
- Can carry more sail area because of higher stability created by the outrigger.
- Less rolling motions — which generally make it more comfortable when fishing.

For the above reasons, the outrigger canoe continues to be a popular fishing craft in the countries where it has traditionally been used, especially with light fishing gear such as hook and line and small-mesh gillnets.

The main disadvantage of an outrigger canoe is that it does not have the same carrying capacity as a monohull because of the narrow beam.

Types of Oru

In terms of number of craft, the Oru is the most important of the traditional craft in Sri Lanka. Some main types of Oru can be distinguished

Paddled or poled Oru for lakes or lagoons - Appendix 2

Rowed Oru for the sea - Appendix 3

Sailing/rowing Oru with double sprit sail - Appendix 4

Sailing/rowing Oru with dipping lug sail - Appendix 5

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Construction of Oru

The construction of the Oru follows the pattern shown in Appendix 6. The main part of the canoe is the dugout made from a single tree. Various species are used, listed in order of preference

Jak wood - kos	—	*Artocarpus heterophyllus*
Gandel Bedidel		*Artocarpus nobilis*
Mara Paramara	—	*Albizzia Odoratissima*
Wild Mango, Etamba	—	*Mangifera Zeylanica*
Mango, Amba		*Mangifera Indica*

The durability of a dugout canoe made of Jak, Gandel or Mara is said to be 20 - 40 years. Jak or Gandel is difficult to obtain in sufficient size and length and the cost is very high. Increasingly, the dugout hull is now made from Wild Mango, Etamba, or Amba obtainable at a cost one third to one fourth that of Jak and Gandel. The service life is however reduced to 10-15 years. An Oru made from Mango wood 8.75m long and 0.60m deep, and with a beam of 0.82m, was said to cost Rs.l5 - 20,000 in Dodanduwa (1989). The cost of the log bought up country was said to be about Rs. 4000.

For construction of a canoe from a 9 m log, the gross volume of timber is about $6.5m^3$ (230 cub.ft.). A planked canoe of the same volume would require only $1.4m^3$ (50 cub.ft.) of sawn timber which amounts to about $2.5m^3$ (90 cub.ft.) in log form. For each dugout canoe one would be able to build between two and three planked canoes. Dugout construction is therefore very wasteful of timber.

The Oru is made in the villages by specialized carpenters. The log is selected up country by the carpenter in consultation with the fisherman. A Government permit is supposed to be obtained for felling and after agreeing on a price with the owner of the land, the tree is felled and transported to the Village. The carving of the dugout hull requires great care in assuring a decreasing thickness from the bottom to the top.

The wash strakes or extended sides are now mainly made from Mango (Etamba, Amba).

The outrigger beams are made from Domba *(Calophyllum inophyllum)*, a strong and flexible timber. The outrigger is carved from *Lunuinidella melia* dubia. It is said to last 4-5 years.

Maintenance and repair

The traditional way to maintain the dugout part of the Oru is to scrub the outside surface with sand, clean it and then apply coconut oil. The oil reduces water absorption and surface cracking of the timber when it dries out. This application is done once a month. No paint is normally used, either on the dugout part or on the extended top sides.

The weakest parts of the dugout canoe are the ends where the core of the tree remains. This weakness explains the extra thickness required and the need for a rounded rather blunt form of the ends. The ends of the canoe crack open after some time and need to be repaired with a piece accurately fitted in place using a shiplap with mastic for watertightness. Copper rivets are placed through the shiplap. Sometimes iron rivets are used for economy.

FRP sheathing of Oru,

On a very old dugout canoe with many cracks and problems of leaking, the owner sometimes uses FRP sheathing on the outside in order to increase the service life. It is very difficult to maintain adhesion between the dugouC hull, shrinking and swelling with variations in humidity, and the FRP skin. The skin will therefore come loose in patches from the hull with the result that pockets of stagnant water will form. The chances of rot are therefore high. An additional problem is abrasion of the **FRP** sheathing on the bottom of the canoe, leading to cracks and water infiltration.

FRP sheathing has been successful on 3 1/2 tonners. **In** this case the poor adhesion of the polyester resin to wood is compensated by using longitudinal battens screwed through the **FRP** coating into the planking. The batten is then covered with a strip of FRP. The FRP sheathing will after some years separate from the hull in patches but this can easily be repaired. The FRP sheathing on the

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3 1/2 tonners is essential to protect against marine borers since the boat stays in water all the time. The canoes are hauled up on the beach after each fishing trip and do not require the same protection. The experience with FRP sheathing of 80 Orus carried out during 1986-87 in Hambantota district shows that FRP sheathing is generally not to be recommended. (Gulbrandsen, 1986).

90% Subsidy FRP Oru:

The Government has since 1983 issued some 1,000 FRP Orus with 90% subsidy to poor fishermen. The most cOmmon size is the 5.5m Oru. Other sizes are 6.4m and 7.3m. The Oru in FRP is a direct copy of the traditional Oru. Acceptance by the fishermen has therefore been assured. Since these craft were mostly rowed there is no great advantage in changing the shape. Often the fisherman provides the beams and the outrigger.

FRP Oru for shrimp trawling in Negombo

The Orus which engage in shrimp trawling under sail and paddle in Negombo are about 1O-12m long, with a dugout log of around 9m long. (See Appendix 4.) The problems with finding logs large enough for these canoes, prompted a local boatbuilder in Negombo to make a FRP copy of the dugout log. No changes were made in the lines of the canoe. The top strakes were still made of wooden planks lashed to the FRP dugout part. The dugout part was 9.25m long with a beam of O.65m and a depth of O.57m. The dugout part is sold for Rs. 28,000 and, as an option, the fishermen can get the raised topsides for an additional Rs. 6,000. Since 1980, a total of 30 hulls have been made, all bought by shrimp fishermen in Negombo.

3. CATAMARAN AND TRIMARAN

6.7m twin hull (catamaran)

BOBP's first attempt in 1979-80 was a twin hull craft with a new sail rig as an alternative to the large Oru. Two FRP hulls of length 6.7m were connected with bamboo beams. (See Appendix 7.) A bamboo mast 9m long carried a single triangular Genoa type of sail. Steering was with a steering oar and sidedrift was prevented by leeboards inserted in slots in the hulls. Sailing trials, however, showed no major advantage in speed compared to the traditional 1O-12m Oru in Negombo. Fishermen showed no interest in trying this new craft as it was radically different from their traditional craft without offering clear advantages. The twin hull craft was later transferred to Batticalao and then to the Tangalle Fisheries Training Centre for further trials. It was reported that the craft was too slow with a 6 Hp outboard engine and that its sailing qualities could not compensate for this. The twin hull concept meant that it was impossible to rely on oars, as could be done with the Oru, when there was no wind. The cost of the twin hull was higher than a comparable Oru because (a) two hulls were required (b) the connecting structure had to be stronger.

The final conclusion of the trials was that the twin hull concept did not offer any advantages for inshore fishery compared with the traditional single outrigger canoe.

6.7m canoe with double outriggers (trimaran)

This craft utilized a single 6.7m hull with two outriggers (Appendix 8). A 6 hp outboard motor was fixed in the stern. The trials showed a speed of about 10 knots with a load of two fishermen and light fishing gear. Trials were conducted in Batticalao by the Fisheries Training Centre and good performance was reported. The increased speed was especially appreciated when surf landing. The canoe was not utilized in long-term fishing trials and no final conclusions can be drawn on the use of the double outrigger canoe. On the basis of experience in other countries having double and single outrigger canoes, it does not seem that the double outrigger will offer any major advantage for the fishery in Sri Lanka. A double outrigger canoe can be made into a better sailing craft than a single outrigger canoe, but only at an increase in cost and complexity.

4. 12M CANOES WITH SINGLE OUTRIGGER

12m canoe for shrimp Irawling under sail

After the disappointing trials with the twin hull, the Oru principle of the single outrigger was retained. However instead of copying the shape of the main dugout hull in FRP as local FRP firms had done, changes were made in hull lines to improve speed. The main departure from the traditional shape was a sharper bow and stern and a more V-shaped midship section. (Appendix 9.)

A 12m FRP prototype was launched in December 1981 at Negombo and tested using a traditional Lunumidella outrigger. Interviews with fishermen who have tried this new design, revealed general

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agreement that the new Oru was faster. However, several fishermen complained of reduced manoeuvrability partly because of the new midship section and sharper ends. Since the fishing grounds were close to Negombo, the added speed was not of great significance while the reduced manoeuvrability was of some concern while handling the trawl under sail.

The cost of the main hull was in 1982 Rs. 31,000. To this was later added an FRP outrigger costing Rs. 12,000 with beams, sailrig and fishing gear.. The total investment was Rs. 50,000.

A 50% subsidy scheme to enable fishermen in Negombo to purchase the new FRP Oru — with a mere Rs 5,000 deposit from them — did not attract many buyers. One explanation could be the rather low income of these crafts. Catch data for 1982 - 1985 show an average of 200 fishing trips per year with a revenue of Rs. 34,500. (Appendix 10). If it is assumed that Rs. 6,500 is required per year for covering maintenance and fishing gear replacement, Rs. 28,000 is left for the crew or only Rs. 7,000 per crew member per year. With this low income, even a deposit of Rs. 5,000 becomes difficult to accumulate.

Of the five 12m Orus built, one was purchased through the loan scheme by a shrimp buyer. The remaining were finally auctioned, two being sold to tourist operators and two to fishermen. The latter two Orus are still operating while the one sold through the loan scheme was abandoned. The owner claims that he could not find crew to operate it because of the difference in handling characteristics. The fact that two of the Orus are operating shows that these objections could be overcome by practice. It can be concluded, however, that Negombo fishermen in general did not find enough advantages in the new canoe to justify the higher cost, compared with the FRP copy of the traditional dugout Oru.

12m canoe for large-mesh driftnet fishing

A further attempt was made to introduce a new large Oru - a 12m FRP single outrigger canoe. Rather than replace something existing, the purpose was now to explore the possibility of using a canoe for large mesh driftnetting, drift longlining and trolling for large pelagic species. If this was, proven to be feasible, the investment and operating cost would be much lower than a 3 1/2 tonner.

A prototype canoe was launched in June 1984 and initially utilized for shrimp trawling without an engine. (Appendix 11). Fishing trials with large mesh driftnets started in February 1985. The canoe was fitted with a 7 hp air cooled diesel engine in a "longtail" side installation. Problems were experienced with the side engine installation hitting the waves and splashing water into the hull. Altogether 14 fishing trips were made with the following conclusions

- The long, narrow hull of the canoe can carry only 20 pieces of nets versus 40 pieces for the 3 1/2 tonner.
- The hauling of nets is more difficult than on a 3 1/2 tonner. The drag of the outrigger means that the canoe is hauled partly sideways into the net. Lack of manoeuvrability with the side installed engine meant that engine power could not be as effectively used as on the 3 1/2 tonner when hauling in bad weather.
- The canoe will not be able to operate in the same weather conditions as the 3 1/2 tonner during the monsoon, which is the best fishing season for large pelagic species.
- The canoe has good sailing performance but with the low fuel consumption of the 7 hp diesel engine, a large saving cannot be expected.

After reaching these conclusions BOBP sold the canoe by auction. The eventual buyer was the fisherman from Negombo originally trained in operating the canoe. The canoe was utilized for shrimp trawling under sail, but at present the fisherman is working on an offshore boat because this gives a better income. He has not leased the canoe to other fishermen because they are not accustomed to the special handling characteristics of this craft although he himself had no difficulty in mastering it.

Trials with new sail cloth

In connection with trying the new canoes, the sail maker consultant to BOBP made a new set of sails from stronger cotton material with a tighter weave than traditionally used. However, the fishermen who tried these new sails complained that the weave was too tight and that they were afraid of capsizing with the canoe in strong wind because the sail would not let the wind through.

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This is an example of a very different approach to sailing than used in western countries where a sail is made as airtight as possible and the sail area reduced by reefing in strong wind. There are no reefing possibilities on the traditional Oru sail and when wind strength is high the permeability of the sail becomes an important safety valve. The sail material used on the traditional Oru is of thin cotton which is tanned brown. The wind blows easily through it. Under light wind conditions, the fishermen throw salt water on the sail with a special scoop to make it less permeable.

5. 8M CANOES WITH SINGLE OUTRIGGER

Plywood prototype (SRL-17)

Unlike in Negombo where there is a sheltered lagoon most of the Orus in the southern part of the country are hauled up on the beach after each fishing trip. This has limited the size of the canoe to 8 - 9m length. (Appendix 5). Some of the larger of these Orus are motorized with 7 hp and 12 hp outboard motors.

Considering this and on the basis of FAO experience with developing outrigger canoes in the Pacific Ocean, BOBP decided to build an 8m prototype canoe of marine plywood for testing out the acceptance of the fishermen to a shape which is quite different from the traditional canoe. The purpose of the changes was to make it faster than the traditional canoe and 18-footers under engine power thereby obtaining savings in fuel. Compared with the traditional canoe, the bow is sharper and the transom wider. Only trials could determine whether these changes would have some negative effects during surf crossing.

Other major changes was the width of the canoe at the top. The traditional canoe of 8m length has a width at the top of 0.40 m while on the new design it was more than doubled, 0.90m. This would facilitate the handling of fishing gear.

The new 8m canoe SRL-l7 (Appendix 12) was initially tested in Negombo in 1984-85. It was found that the craft could handle the same types and amount of fishing gear as an 18-footer and had one knot higher speed when fitted with the same 7 hp outboard engine. Compared with a traditional Oru of 8m it had the same speed in open water with a 7 hp outboard engine as the traditional Oru with a 12 hp engine.

The trials in Negombo showed, however, that fishermen using 18-footers objected to the increased space taken up by SRL-l7 on the beach. The 18-footer has a beam of 1.75m while the SRL-17 has an overall beam of 3m. This is a specific problem for Negombo with its large concentration of 18-footers.

The SRL-17 was shifted from Negombo to a village north of Beruwala (Maggona) in 1986 and tested over a period of two months (March-April) in handline fishing. This was not proven to be economically feasible, so more diversified fishing methods were required.

In June 1986, the SRL-l7 was shifted to Doddanduwa, a beach based fishing centre near Galle, where some 100 8-9m traditional outrigger canoes operate mainly gillnets and ring nets throughout the year. The SRL-l7 prototype outrigger canoe was handed over to a local fisherman who was put in charge of the fishing operation and was recording the data on expenses and revenue. However, the data collected by the fisherman was found to be unreliable for economic analysis.

The fishing demonstration went on till September 1987. The outrigger canoe was then sold on auction to the cooperating fisherman who has been operating this outrigger canoe continuously.

The operation of the SRL-17 from Doddanduwa proved that

- The changes in design are acceptable to fishermen, since there are major advantages in fuel economy and space for handling fishing gear.
- The new canoe is somewhat more difficult to handle in the surf than the traditional canoe. However, the fact that the canoe has been beachlanded over a period of three years without a capsize shows that this is not a major concern.

The SRL 17 was built in India with marine plywood not readily available in Sri Lanka. There was, therefore, a need to design a new outrigger canoe in Sri Lanka similar to SRL-l7 but suitable for timber or FRP construction. Acceptance by the fishing community could be ascertained through extensive fishing demonstrations.

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Choice of construction material

Plywood is being manufactured in Sri Lanka, mainly to make boxes for packing tea for export. The plywood factory can make marine plywood on request but there is a long delay in delivery and local boat builders maintain that it is not of good quality. Indian marine plywood, which has been used extensively for canoe building in Kerala would become too expensive in Sri Lanka because of high import duties. The choice in construction material then gets limited to two : FRP or planked wooden construction.

FRP. Sri Lanka is the country in Asia where FRP has made the biggest impact on fishing boat construction. About 7,000 FRP 18 footers have been built over the last 15 years. Many thousand traditional type canoes have also been built in FRP. It was therefore clear that FRP would be one of the alternatives to try out for the new 8m canoe. No particular problem was foreseen in building the canoe in FRP. Given the design, there are local skills available in building the plug, mould and the canoes with minimal assistance from BOBP.

Planked construction : The following reasons made the project look into the alternative use of local timber for canoe construction.

- The projections made by the Ministry of Lands and Land Development indicate that timber log supply by the year 2000 could be about twice as high as it is today and that the main supply will come from teak plantations. (Appendix 13.)
- The total dependence on FRP for boat construction could lead to a crisis if imported materials increase rapidly in cost.
- Depending on species of timber, a planked canoe will be cheaper than an FRP canoe.
- Local construction and repairs in the villages by canoe builders is feasible.

The sawn timber presently available in Sri Lanka is of short length mainly 2.5 - 4 m. In the preparation of the designs for the wooden canoes this must be taken into consideration..

Appendix 14 gives information on timber species that at present (1989) can be considered for canoe construction.. Depending on the locality, there are other species that could also be considered. The most common timber for dugout canoe construction now seems to be the Etamba and the Amba. Although it is considered a timber of low durability, there are examples of canoes 15 years old still in use. Possibly the salt water has some preserving effect. The construction of a 8m canoe including a wooden outrigger requires 1.50m3 (53 cub.ft.) = 645 sq.ft (I" thick) of timber. At present prices (Nov.'89), the estimated cost of the canoe would be as shown below

Timber	Price (I" thickness)	Timber	Fastenings etc.	Labour + profit	Total cost
	Rs./sq. ft.	Rs.	Rs.	Rs.	Rs.
Amba	10	6 500	6 000	8 000	20 500
Etamba					
Domba	22	14 000	6 000	8 000	28 000
Gandel	28	17 800	6 000	8 000	31 800

The fisherman therefore has a choice on the level of investment. This is important in a situation where no subsidies are available, and the fisherman depends on local credit to finance the canoe.

Short plank construction (SRL-18):

This canoe was launched in March 1988. (Appendix 15.) It is of planked construction using two layers of cross-planking on the bottom and diagonal planking on the side (Appendix 16.) This construction method makes possible the use of short planks. The timber utilized was mango (Amba) pressure treated with Tanalyte to improve the durability. Fastenings were hot-dip galvanized nails and bolts. Because the right gauge of wire nails were not available these had to be cut from longer nails and then hot-dip galvanized.

After technical trials in Negombo, the SRL-l8 was transferred to Dodanduwa for fishing trials and has been operated continuously. In February 1990, it was auctioned and sold to a fisherman in Dodanduwa at the price of Rs. 12,000.

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This planked canoe has been operated for 1 1/2 years through two monsoon periods without any major problems. In the beginning the fisherman complained about some leaks after the canoe had been drying out on the beach over several days. Since it was a BOBP canoe he expected the project to attend to it. It was explained that he had to take care of such minor details and since then there has been no complaint. There is some visible corrosion of the carriage bolts used in the frame constructions. These were only electroplated because hot dip galvanized bolts were not available. The hot dip galvanized nails show no sign of corrosion. For any new craft, c9pper fastenings will be used since a supply of cheap locally made copper nails has been located. The outer planking in the midship area is starting to get worn and will have to be changed soon. This can easily be done by a village carpenter. The SRL-18 is the type of construction that at present seems most appropriate for village-level canoe building, since it relies on mechanical fastenings and not glue.

Strip plank construction (SRL-19):

The SRL-19 is an outrigger canoe with a general arrangement as similar to SRL-18. It has strip-planked construction in the bottom, with battens 25 x 30 mm nailed and glued together and diagonal planking on the side. (Appendix 17.) This design was prepared with the intention of using small sections of teak available from plantation thinnings. Difficulties developed in the supply of teak from the State Timber Corporation and jak *(Artocarpus heterophyllus)* had to be used for the construction of the prototype. Jak is the favoured timber for wooden boat building in Sri Lanka, but is in great demand and expensive. It is therefore not recommended for future canoe construction. The use of this timber for the SRL-19 was justified because one was mainly testing the method of construction.

The SRL-19 was transferred to Doddanduwa together with SRL-l8. It is still being operated by a local canoe fisherman in Doddanduwa.

The strip planked bottom developed cracks after only one month's fishing from Doddanduwa. The fracture was in the glue line of the flat bottom part. The reason is probably due to one tin of epoxy glue being stored too long. The curved part of the bottom is in addition to the glue also fastened with hot dip galvanized nails. There is no sign of cracking here.

The glue line failure should not mean that the strip planked construction should be discarded, but it points to the problem of using glue in a tropical environment and especially at the village level, where the humidity of the materials used might be high. The strip planked construction was mainly intended to be made from small size teak not suitable for export and with the increasing teak supply, this construction method could still be considered in the future. The SRL-l9 was repaired and will be kept in operation to gain further experience with the durability of this construction method.

Engine trials

After construction of the prototypes SRL-18 and SRL-l9, was completed, trials to measure speed and fuel consumption were performed in calm water in Negombo. Speed was measured with an electronic log towed outside the wake of the canoe. Fuel consumption was measured on the basis of the time taken to consume 100 cc of fuel. Comparative trials were also made with a standard 18 footer using the same 7 hp outboard engine and the same load of 400 kg (6 men). It was concluded that the outrigger canoes are performing considerably better than the FRP 18 footer

- The outrigger canoes have a maximum speed which is 1.5 knots higher than that of the 18 footer, 7.8 knots versus 6.3 knots.
- Fuel-saving of 17¾at full throttle.
- Fuel-saving of 48% at a reduced speed of 6.3 knots (the maximum speed of the 18 footer)
- There is no difference in performance between the flat-bottomed SRL-l8 and the round bottomed SRL-19.

Details of the measured results are shown in Appendix 18a.

The effect of different outriggers using the same load of 400 kg is shown in Appendix l8b. The spacing of the outriggers from the centerline of the main hull was 2.5m. The poor result of the traditional outrigger is mainly due to the heavy weight.(150 kg versus 43 kg for the FRP outrigger and 32 kg for the PVC outrigger). Moving the traditional outrigger from 2.5m centerline spacing to 2.8m decreased the speed by only 0.1 knots. Appendix l8c shows how speed and fuel consumption vary with different lOads of SRL-19.

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Sailing trials

The dipping lug sail tested on the prototypes is identical to the one commonly used on the sailing Oru on the south west and south coast. The rigging is simplified using the halyard as a stay. Although a better sailing performance can be achieved by using a Gunter main sail with a jib such as on SRL-l 7, experience shows that the use of sail by the fishermen is not sufficient to justify the added cost and complexity. What is required is the simplest rig that will ensure a reasonable performance as an emergency sail and possibly for fuel saving when the wind is favourable from abeam and aft. The dipping lug satisfies this criterion.

Fitted with a PVC dipping lug sail of 12.6m^2, the SRL-19 showed a-good performance with wind more than 70° from the bow. At 90° to the wind, sailing speed was 6.0 - *6.5* knots in a wind strength of about 17 knots. A leeboard of 0.4 x l.6m permits the canoe to go higher into the wind but the improvement was not sufficient to justify the complications considering that the sail will be used only for emergency. The PVC material in the sail is a long lasting material which also serves well as a tarpaulin against rain. The price is however considerably higher than for the thin cotton material used in the traditional sail.

The sailing trials showed that a reserve buoyancy of the outrigger of about 140 kg is required to obtain a satisfactory righting moment. This means two men standing on the outrigger before it is submerged. The PVC pipe outrigger made from a 160mm pipe of 6m length filled with polystyrene did not satisfy this criteria. A pipe of 225 mm would be required. The FRP outrigger fitted on SRL-18 and SRL-l9 performs very well, but the cost is high (Rs.7,000). The final version SRL-18 therefore has a planked outrigger using polystyrene as buoyancy material. (Appendix 19.)

Commercial fishing trials

The two prototype canoes SRL-18 and SRL-19 started fishing from Doddanduwa in June 1988. The main fishing gears used were

a) Driftnet for small tuna and Indian mackerel

Length of nets	=	1.0 km
Depth	=	10 m
Cost (Nov.'89)	=	Rs.20,000
Crew	=	3 men
Main fishing season	:	May - Sept - but used all year

b) Ringnet for half beak fish or auxis tuna

Length of nets	=	200-230 m
Depth	=	16-20 m at the middle and 10-12 ni in the ends.
Cost (Nov.'89)	=	Rs.20,000
Crew	=	6 men
Fishing season		September - April.

Experience from operating the SRL-17 had shown that data recording could not be left to the fisherman. A young man from the village was therefore engaged by BOBP for collecting data on SRL-18 fishing trips. Data were collected over a full one-year period, June 1988 - May 1989. The SRL-19 was out of operation for several months and was not monitored.

The record of SRL-18 is as follows

Total fishing days	208
Average fishing days/month	17
Total catch in kg	7,035
Gillnet catch iii kg	2,406
Ringnet catch in kg	4,629
Average catch in kg/day	34
Value of catch in Rs	139,402
Operating costs in Rs [1]	44,186
Crew share in Rs	53,492
Boat owner share in Rs	41,724
Crew share Rs/man/month	923
Crew share Rs/man/fishing day	53
Internal Rate of Return in % [2]	69

[1] Includes insurance 2.2% of investment cost and repair/maintenance about 10% of investment cost.
[2] The IRR calculation is based on the following investment cost and life-span.

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Investment	*Rs.*	*Yrs.*
Craft	27,000	10
Engine	27,000	3
Fishing gear - ringnet	20,000	7
Fishing gear - gillnet (20 pieces)	20,000	7
Total	94,000	

The production details and the cash flow are shown in Appendix 20.

In connection with the monitoring of SRL-.l8, data were also collected from a traditional Oru operating from the same site. No ring net was employed, only gilinets. This Oru operated only during 144 days so the overall performance is not comparable with SRL-18. But let us compare the monthly average catch rates in kg/day.

Period	SRL - 18		Traditional
	Gillnet	Ringnet	Gillnet
Jun - Oct.	33	—	40
Nov - Mar.	—	39	23
Apr - May	*IS*	—	29
Jun - May	28	39	29

The ring net produced a higher catch rate during the winter months and was therefore preferred during that period. However, during five months of the year this operation requires an additional investment of Rs. 20,000 and three additional men. Had only gillnets been used assuming an average catch rate of 29 kg/day as for the traditional Oru then IRR would have been only marginally lower, 65%.

Therefore, regardless of the use of ring net as an additional gear the SRL-18 is an economically viable proposition.

6. FUTURE DEVELOPMENT

Construction materials

One of the main purposes of the project has been to evaluate alternative construction materials for the traditional dugout canoe. The planked canoe SRL-l8 has been proven over 1 1/2 years of operation from Doddanduwa to be technically feasible. The strip planking method is not recommended and, instead, a FRP version of SRL-l9 has been made. The fisherman operating the 7-9m Oru with an outboard engine now has a choice of three alternatives when he needs a replacement for his canoe

- A new dugout canoe of the traditional type
- A planked canoe
- An FRP canoe

Prices of materials will fluctuate in the future. It is difficult to predict what the relative cost of these alternatives will be in 5 or 10 years. In this situation it is important that the fishermen have a choice of alternatives in terms of investment.

Since the project's main work has been carried out in Doddanduwa village, a start should be made there by giving fishermen an offer of two alternatives planked construction or FRP construction.

The cost of the latter is to be based on quotations obtained from FRP boatyards. In a start-up phase for the first four canoes, a subsidy could be given that covers the cost of labour and fastenings and miscellaneous costs for the wooden canoe (about Rs. 14,000). The fisherman will have to pay

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for the timber – Rs. 6,500 for the cheapest timber (Mango) or Rs. 17,000 for the most expensive timber (Gandel.)

The same Rs. 14,000 should be offered as subsidy for the FRP canoe. The preference of Doddanduwa fishermen for wooden or FRP construction will indicate what direction the canoe development project should take in the future.

Engine

The total yearly cost to operate the SRL-l8 with a 7 hp outboard engine, using a combination of gillnets and ringnet, can be broken down as follows

Engine (Fuel, Depreciation, Repairs, Insurance),	32,454	(28%)
Craft (Depreciation, Repairs, Insurance)	5,994	*(5%)*
Fishing gear (Depreciation, Repairs, Insurance)	10,594	(9%)
Miscellaneous	3,148	(3%)
Crew (Crew share, Food)	62,902	(55%)
Total yearly cost	115,092	(100%)

The biggest item is the crew cost at 55% of the total operating cost. No saving can be expected on this item. Potential saving on fishing gear and miscellaneous costs is small. With the alternative planked canoe construction, there is no potential for further saving on the craft. The only item with potential for saving is the engine, which accounts for 28% of the total operating cost.

At present, the 7 hp and 12 hp kerosene outboard engines are the only alternatives for the motorized Oru. When the economic evaluation of the canoes was made (mid-1989), the price of the 7 hp outboard engine was Rs. 27,000. In November 1989 this had risen to Rs. 36,000. In view of this price escalation and the cancellation of the Government's 50% subsidy for replacement engines, other alternatives to the kerosene outboard engine should be investigated.

During one year's operation the SRL-l8's outboard engine ran for approximately 690 hours. Fuel consumption is about 3.6 litre per hour, totalling 2,500 litres per year at a cost of Rs. 19,900 (Rs. 8.00 per litre, kerosene + oil + petrol for starting). A diesel engine of the same power would consume 1.8 litres per hour or 1,240 litres per year at a cost of Rs. 13,000 (Rs. 10.50 per litre). The saving in fuel cost is Rs. 6,900.

The present cost of the 7 hp outboard engine is Rs. 36,000 and the yearly depreciation is Rs. 12,000. Since the diesel engine can be depreciated over five years versus the outboard engine over three years, the diesel engine with installation can cost up to Rs. 60,000 and still have the same yearly depreciation cost. If the cost can be reduced to Rs. 50,000 there is a yearly saving in fixed cost of approximately Rs. 2,000 in addition to the fuel saving of Rs. 6,900. This potential saving of Rs. 8,900 is about 8% of the total operating cost. It is equivalent to about 10% higher IRR.

In Asian countries such as Indonesia and Thailand,outboard engines are used only to a limited extent in the small-scale fisheries. The dominant propulsion unit is the horizontal single cylinder water-cooled diesel engine and the smaller air-cooled petrol or kerosene engines. Because these engines are mass-produced the cost is relatively low. A 5 hp horizontal cylinder diesel engine can be bought in Colombo for Rs. 19,000 (Nov.'89), This involves a permanent installation in the boat, whose weight will be about 110 kg compared with 30 kg for a 7 hp outboard engine. The added weight might make hauling up the beach more difficult. The air-cooled petrol and kerosene engines are lighter, but they are mostly made in the 2 - 5 hp range.

In 1989, trials were done using SRL-19 fitted with a 5hp air-cooled diesel engine and a ''longtail'' on the port side of the canoe. The trials showed that there are problenis of splashing when the underside of the engine box hits the waves. There is also considerable corrosion on the installation because of using unprotected steel.

In view of' the potential economic gain by using this type of engine, trials should be continued with different types of diesel engine installation on beach landing canoes to determine the technical

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feasibility. A requirement would be that the installation maintains the advantages of the outboard engine

* Proper marinizing to protect against corrosion.
* High manoeuvrability to maintain sufficient control when going through the surf and landing on the beach
* Tiltable propeller and rudder to reduce draft and make beachianding possible.
* Speed comparable to that of outboard engine

Other canoes

The 8m canoe developed will be able to fish with the same fishing gear as the 18 footer with a lower running cost. Its potential is mainly in the south west, south and east coast up to Trincomalee where Oru craft are used. In addition to this size of craft, a need can be envisaged for two smaller canoes

* A canoe of 6 - 7m length with a 3-5 hp engine
* A canoe of about 5.5 - 6 m length for rowing and sailing

In terms of investment these craft would bridge the gap between the present traditional small Oru and the 8m canoe.

It is always easier to introduce a motorized craft than a non powered sailing craft. Nevertheless the fact is that there remains a large number of non powered canoes exploiting the inshore waters. The potential to improve the sailing performance by better hull lines, leeboard/centreboard and a more buoyant outrigger needs to be investigated. The problem will be to keep the cost down to near the present Oru, If dugout logs can still be found cheaply for the smaller canoes, there is a potential for increasing sailing performance and ease of handling by fitting a more buoyant planked outrigger at a low cost on existing canoes. Because of the large number of non-powered canoes in existence, work in this field seems justified.

7. **SUMMARY** AND CONCLUSIONS

Traditional craft, non-motorized and motorized employ about half the fishermen population and land 30 - 40% of the catch.

In terms of numbers, the traditional single outrigger canoe, the Oru, is the most important with about 4,400 non-motorized and 700 motorized craft.

The large logs required for dugout canoes of 8-12m length are increasingly difficult to find. Canoes are now mainly made from mango wood (Etamba, Amba).

FRP sheathing of dugout canoes to increase service life has not been successful.

Several thousands of non-motorized Oru made with **FRP** in lengths of 5.5 m to 7.2m have been issued by the Government at 90% subsidy.

The trials with a 6.7 m twin hull (catamaran) showed that this craft is not a suitable alternative to the single outrigger canoe.

A 12m FRP Oru did not succeed in the sailing trawl fishery for shrimp from Negombo because the fishermen preferred cheaper alternatives in FRP, more similar in shape to the traditional outrigger canoe.

Fishing trials with a l2m FRP Oru indicated that this size and type of craft, although cheaper, is not a suitable alternative to the monohull boat for offshore large mesh driftnet fishing.

A new 8m canoe (SRL-17) working from Doddanduwa proved that a different hull shape was accepted by the fishermen, provided there were major advantages in fuel economy and working space.

Future alternatives to the dugout Oru in Sri Lanka will have to be either wooden planked construction or FRP. Good quality marine plywood is not available locally. The future supply of timber will, according to the forestry Master Plan for Sri Lanka, increase to about twice the present volume by the year 2000. The main supply will come from teak plantations.

Two alternatives of 8m canoes of wooden construction have been tested:

SRL-18, planked flat bottom construction
SRL-19, strip planked, round bottom construction

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Technical trials showed no difference in speed between these two hull shapes. Actual fishing trips have proven the technical feasibility of both types. But problems did occur with the strip planked version due to the quality and/or application of the epoxy glue.

The **SRL-18 and SRL-19** have a much better performance than the standard 18 footer tested with the same 7 hp outboard engine and the same load of 400 kg. The two canoes had a maximum speed of 7.8 knots versus 6.3 knots for the 18 footer.

The SRL-l8 and SRL-l9 have a good sailing performance with a traditional dipping lug sail of 12 m^2. Sailing close to the wind can be improved by using a leeboard but this is not considered justifIable for the very limited use of sail that is at present practised by the fishermen on outboard powered craft.

Fishing trials with SRL-18 using gillnets and ringnet from Doddanduwa have amply demonstrated the economic viability of this type of canoe.

The economic return of the SRL-l8 could be further improved by the use of a diesel propulsion system which has a low running cost.

Initial trials using SRL-19 fitted with a 5 hp air cooled diesel engine and a "longtail" showed that problems of splashing and corrosion needs to be solved. Other types of inboard installation should also be tested. It is however essential to retain the beachlanding capability of the outboard engine.

There might be a need to develop two smaller single outrigger craft

* 6 - 7m canoe with 3.5 hp engine
* **5.5** - 6m non-motorized canoe with improved sailing performance.

8. REFERENCES

T Vassdal, 1984	Costs and earnings analysis of fishing vessels and fishing methods, Hambantota.
Ministry of Lands and Land Development, 1986	Forestry Master Plan for Sri Lanka
Gerhard Kapitan, 1987	Record of native craft in Sri Lanka (I) - The single outrigger fishing canoe Oruwa. Part 1.2 Sailing Oru.
0 Gulbrandsen, 1986	**Evaluation of fibreglass coating of Oru.**

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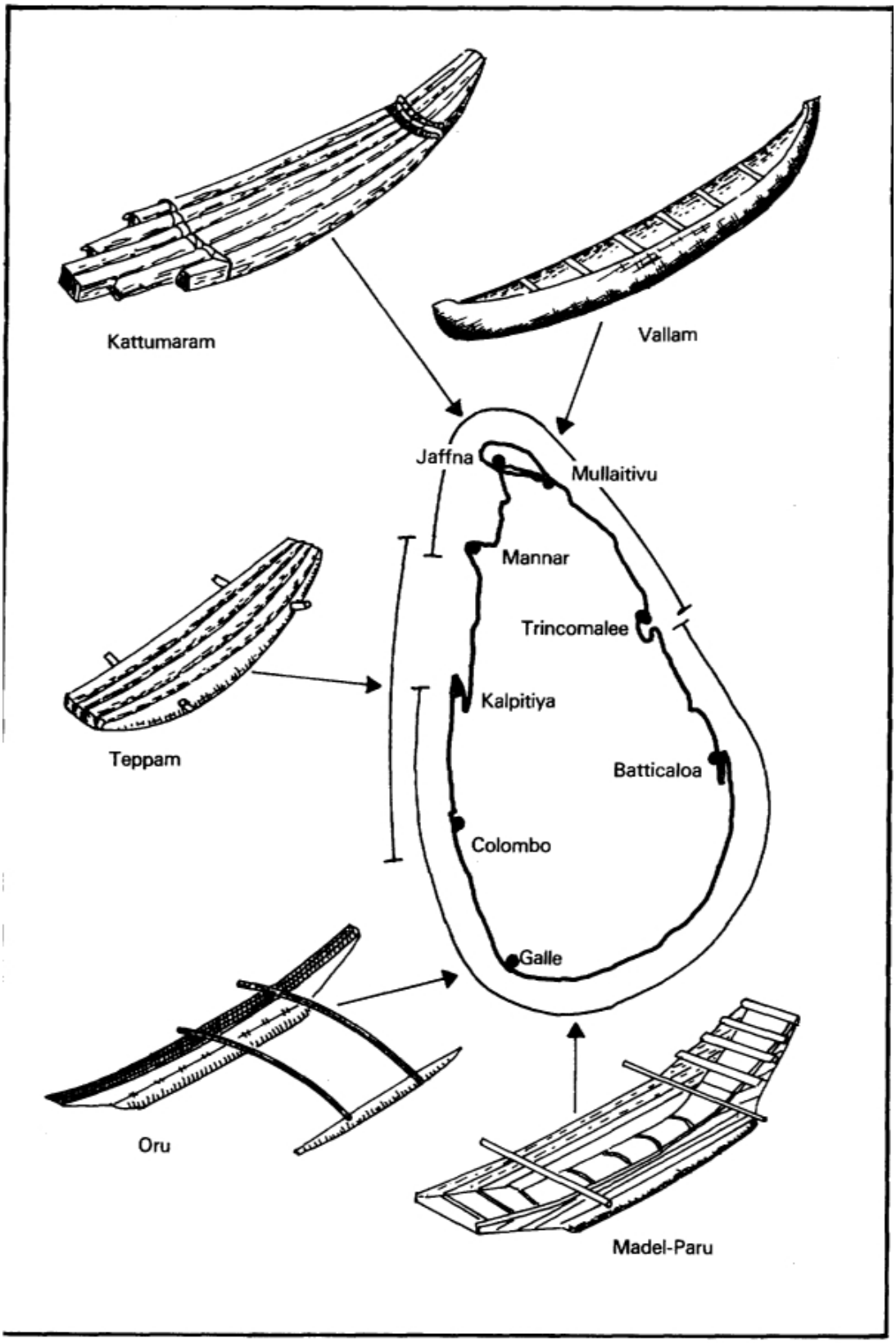
Appendix 1

TRADITIONAL CRAFT



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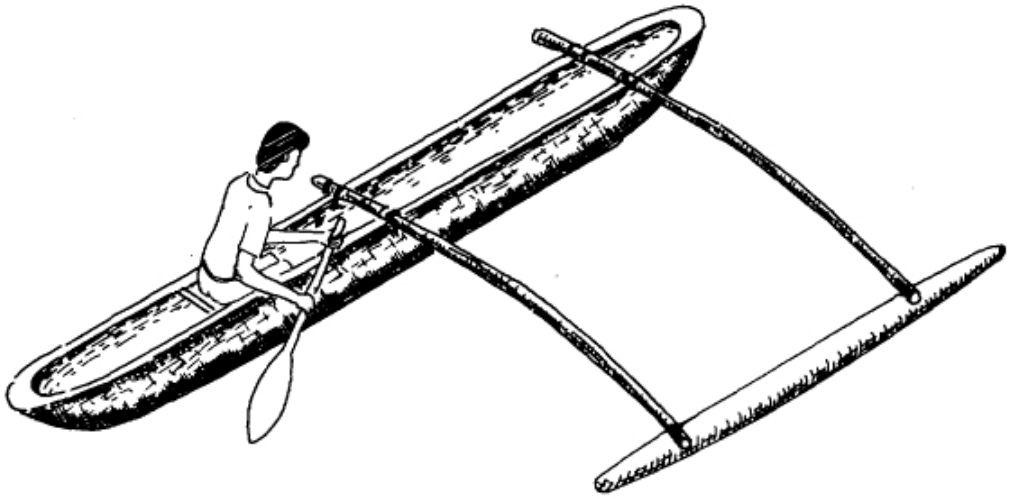

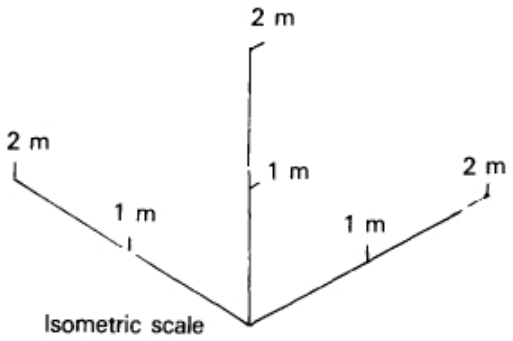

Length overall	=	5.2 m
Beam main hull	=	0.5 m
Depth main hull	=	0.5 m
Cubic number	=	1.3 m^3
Center distance main hull - outrigger	=	2.5 m

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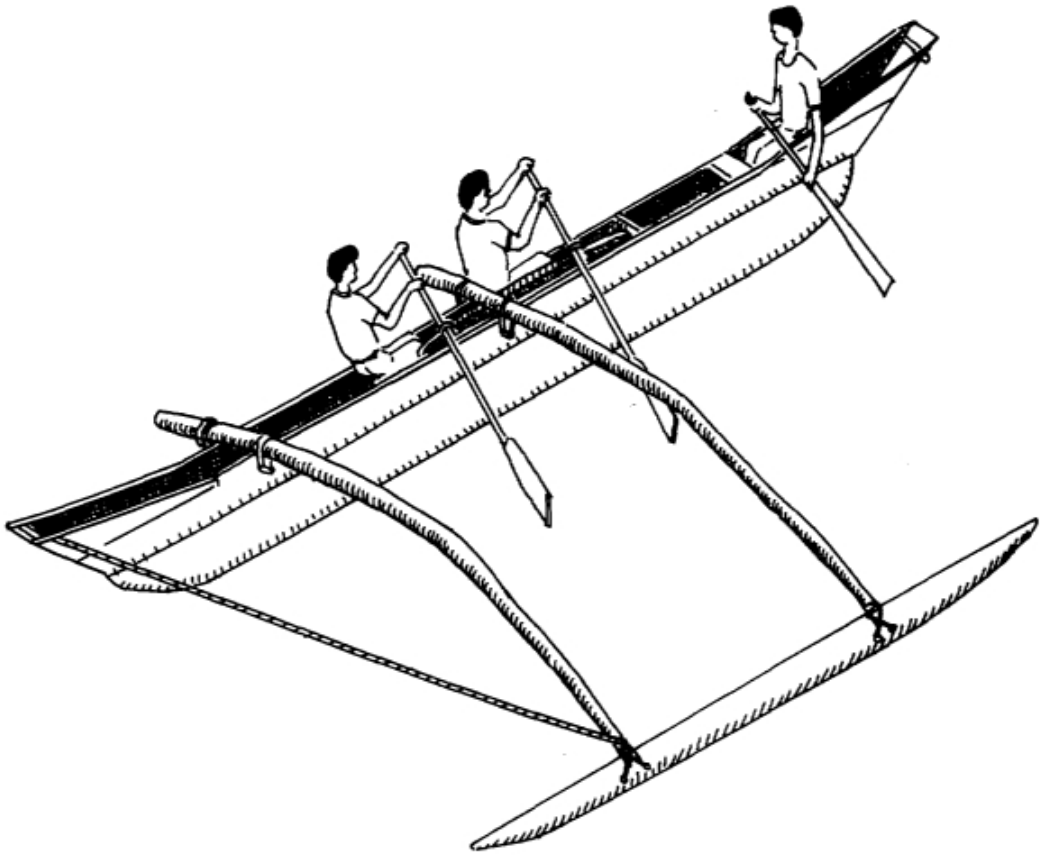
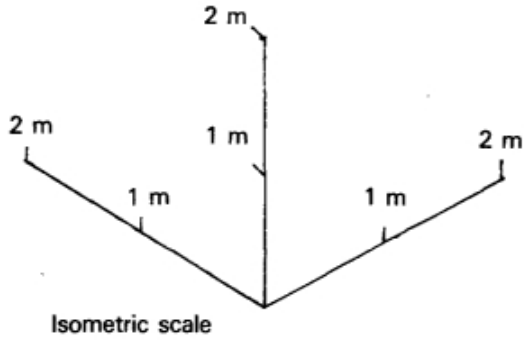
Palu-oru, Doddanduwa





Length overall	=	7.50 m
Beam main hull	=	0.55 m
Depth main hull	=	0.77 m
Cubic number	=	3.2 m^3
Center distance main hull - outrigger	=	3.3 m

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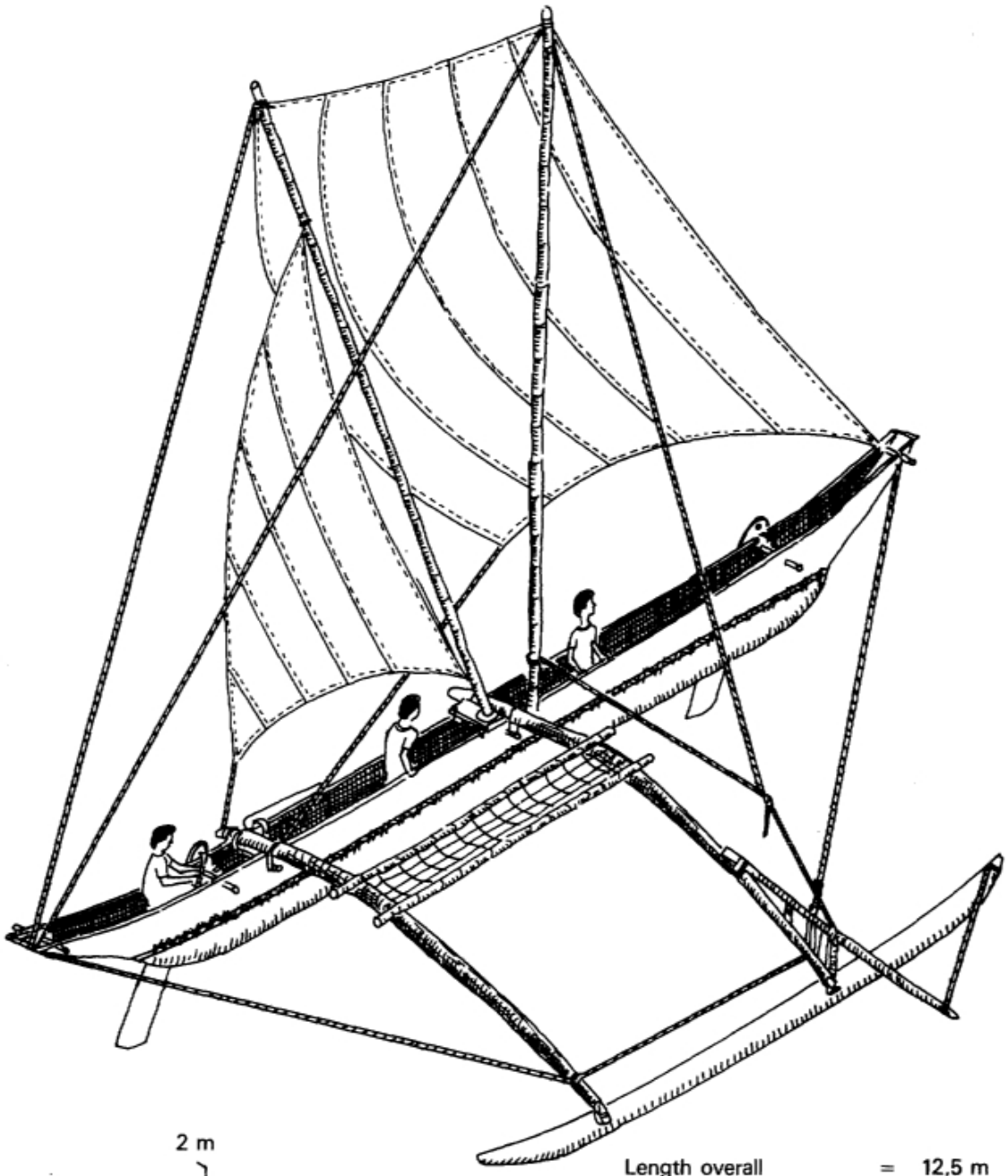
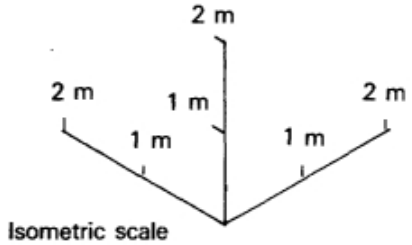
Bala-oru; Negombo

Double Sprit sail is used from Beruwala to Kalpitiya





Length overall	=	12,5 m
Beam main hull	=	0.65 m
Depth main hull	=	0.90 m
Cubic number	=	7.3 m^3
Center line distance main hull - outrigger	=	5.0 m
Sail area : Sprit sail	=	33 m^2
Triangular sail	=	9 m^2

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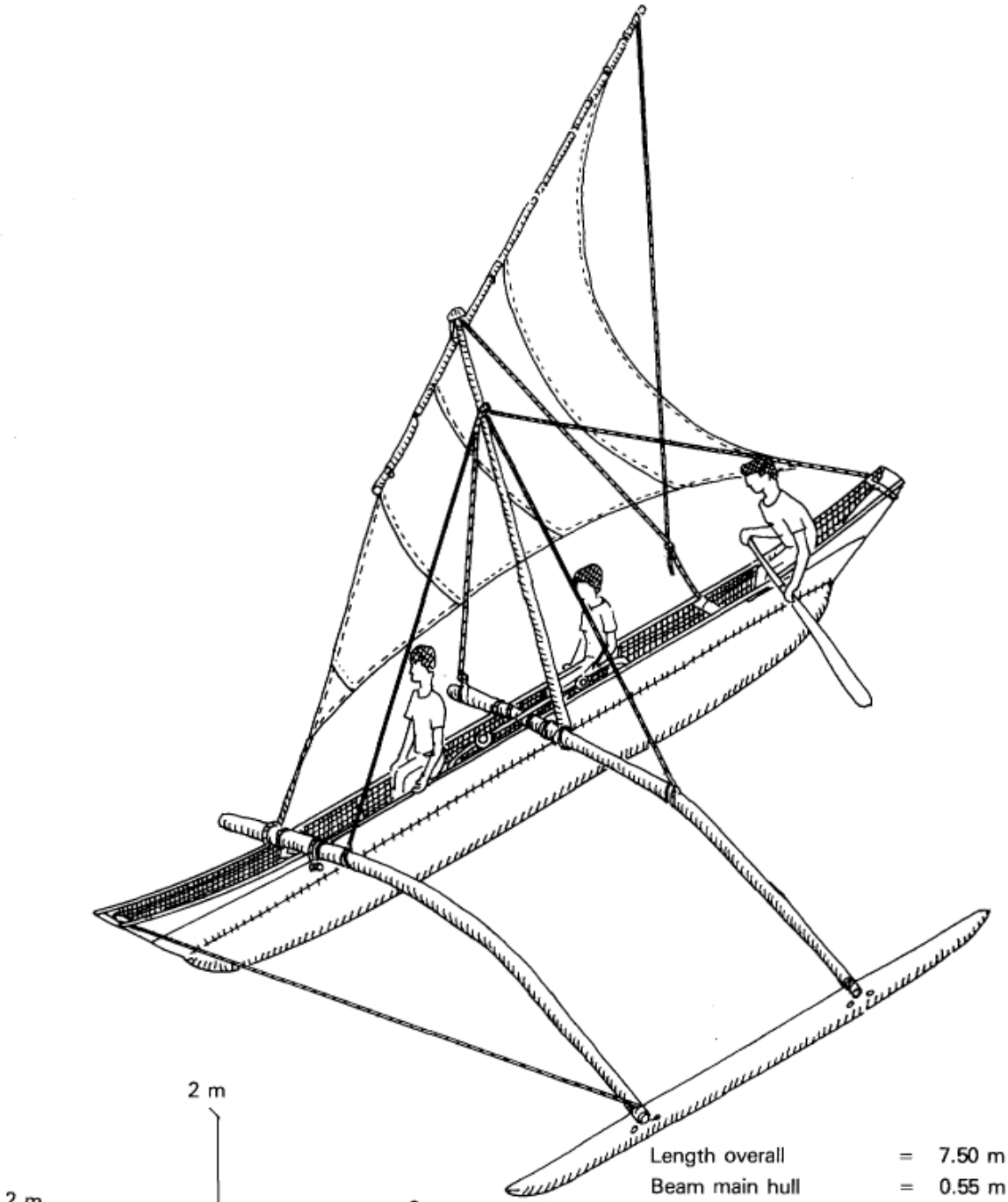
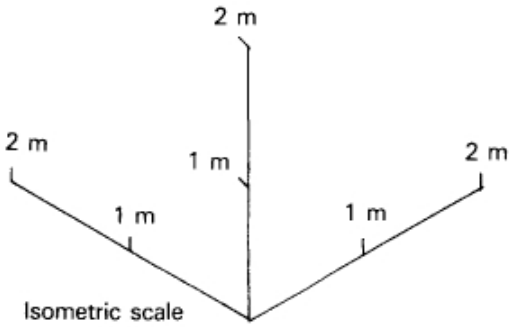
Dipping Lug sail is used from Beruwala southward and up to Trincomalee on the east coast.





Length overall	=	7.50 m
Beam main hull	=	0.55 m
Depth main hull	=	0.77 m
Cubic number	=	3.2 m^3
Center distance main hull - outrigger	=	3.3 m
Sail area	=	11.5 m^2

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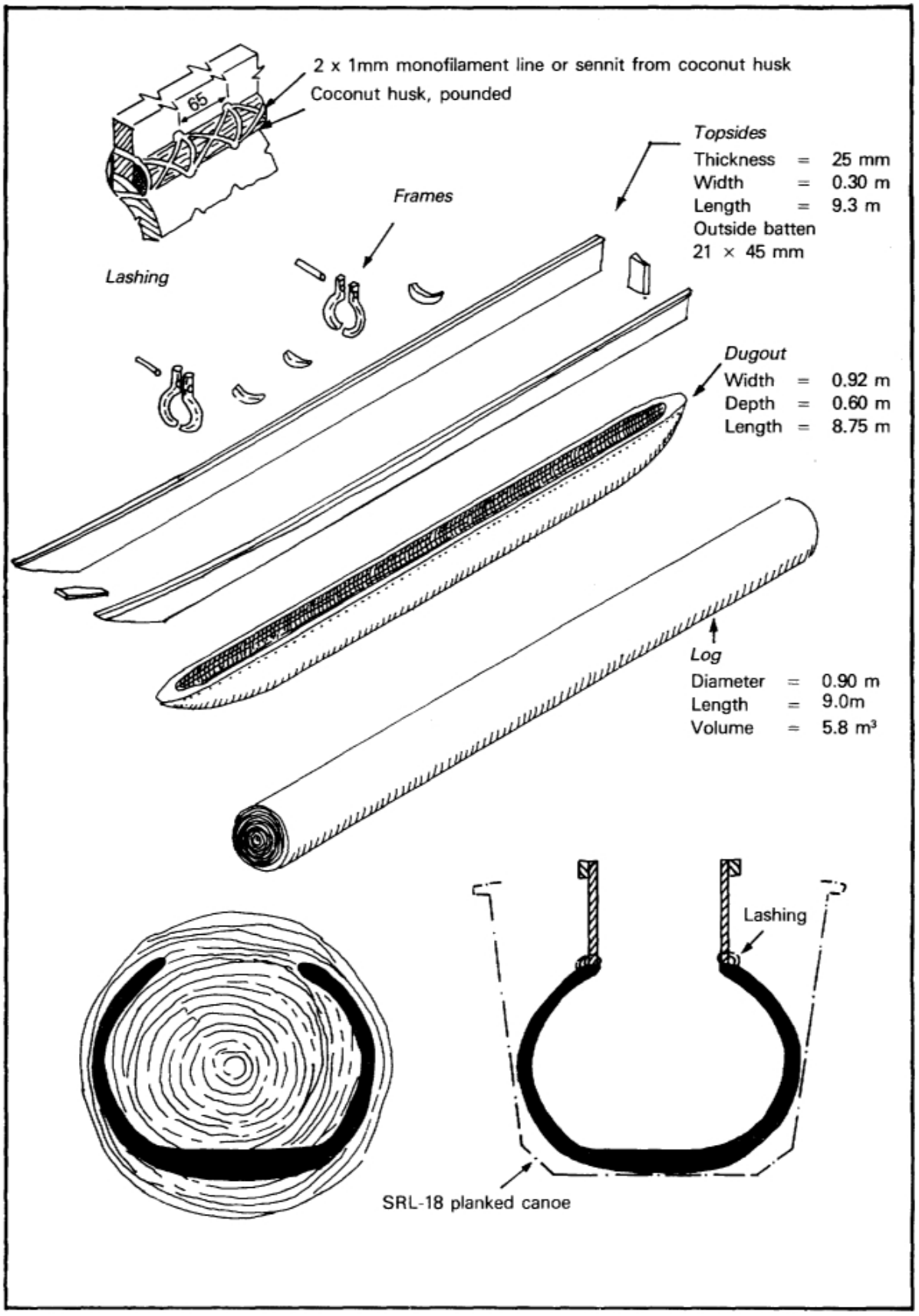
2 x 1mm monofilament line or sennit from coconut husk
Coconut husk, pounded
65
Topsides
Thickness = 25 mm
Width = 0.30 m
Length = 9.3 m
Outside batten
21 × 45 mm
Frames
Lashing
Dugout
Width = 0.92 m
Depth = 0.60 m
Length = 8.75 m
Log
Diameter = 0.90 m
Length = 9.0m
Volume = 5.8 m³
Lashing
SRL-18 planked canoe

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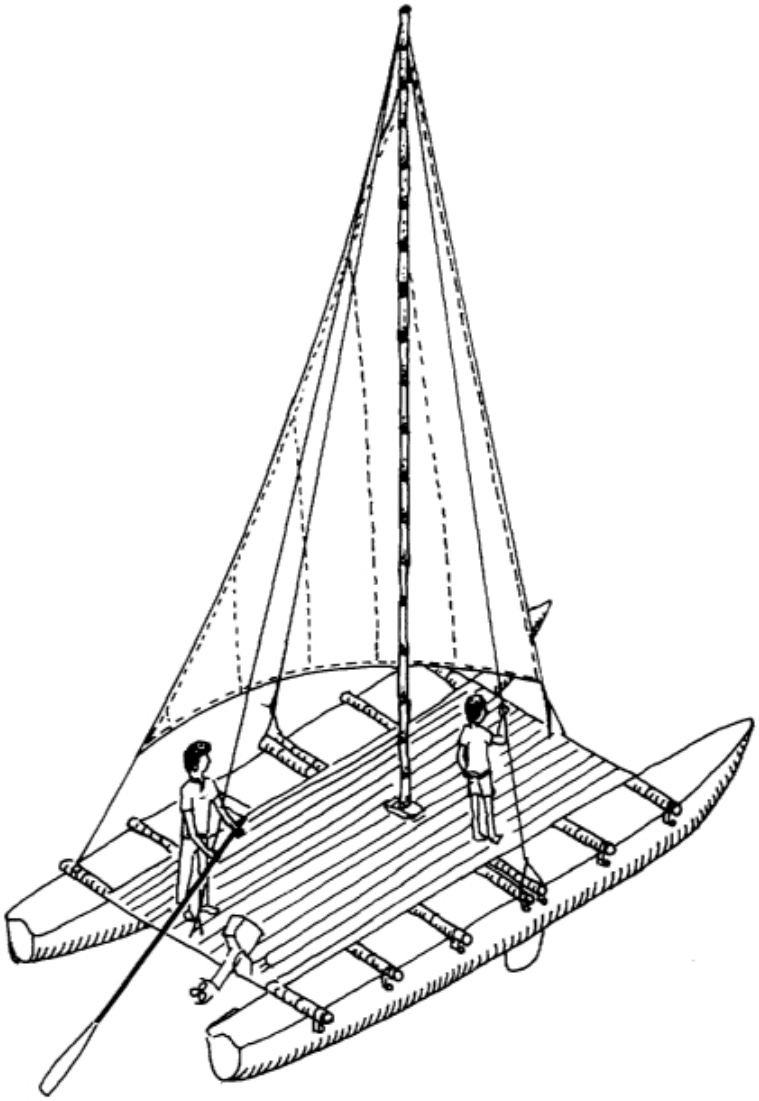
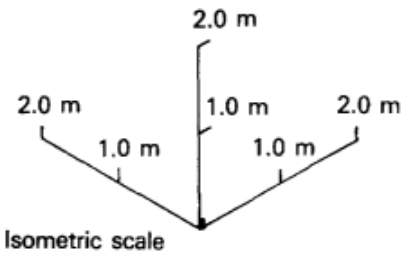
Appendix 7 **CATAMARAN**

(Motor-sailing prototype)





Length overall	=	6.75 m
Beam each hull	=	0.55 m
Depth each hull	=	0.68 m
Cubic number 2 hulls	=	5.0 m^3
Center distance hulls	=	2.5 m
Mast length (Bamboo)	=	9.0 m
Sail area	=	21.0 m^2
Auxillary outboard	=	6 hp
Beam overall	=	3.2 m

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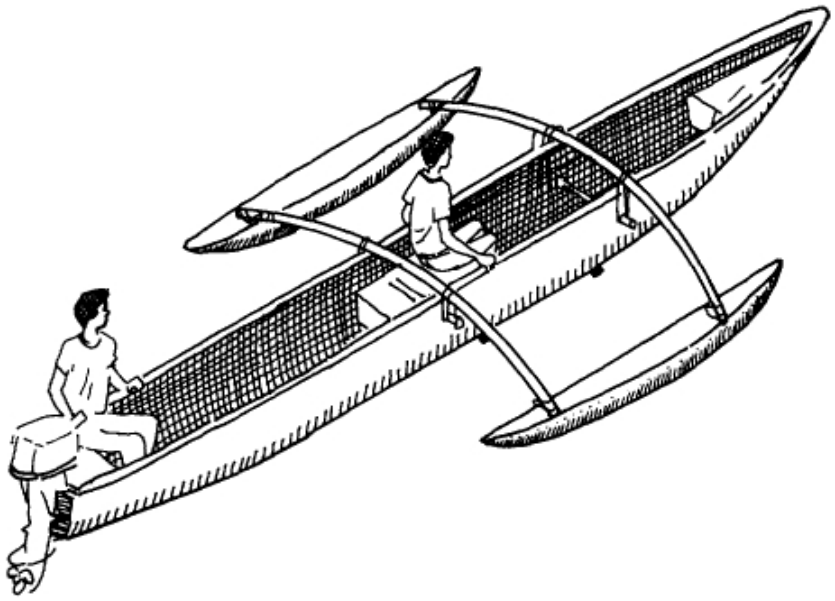
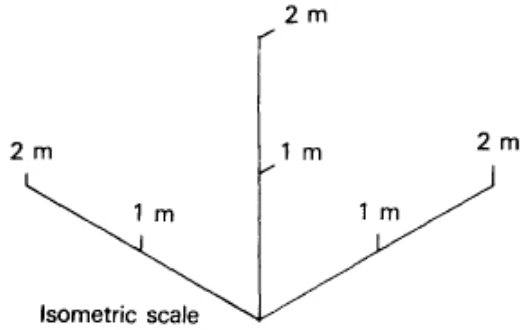
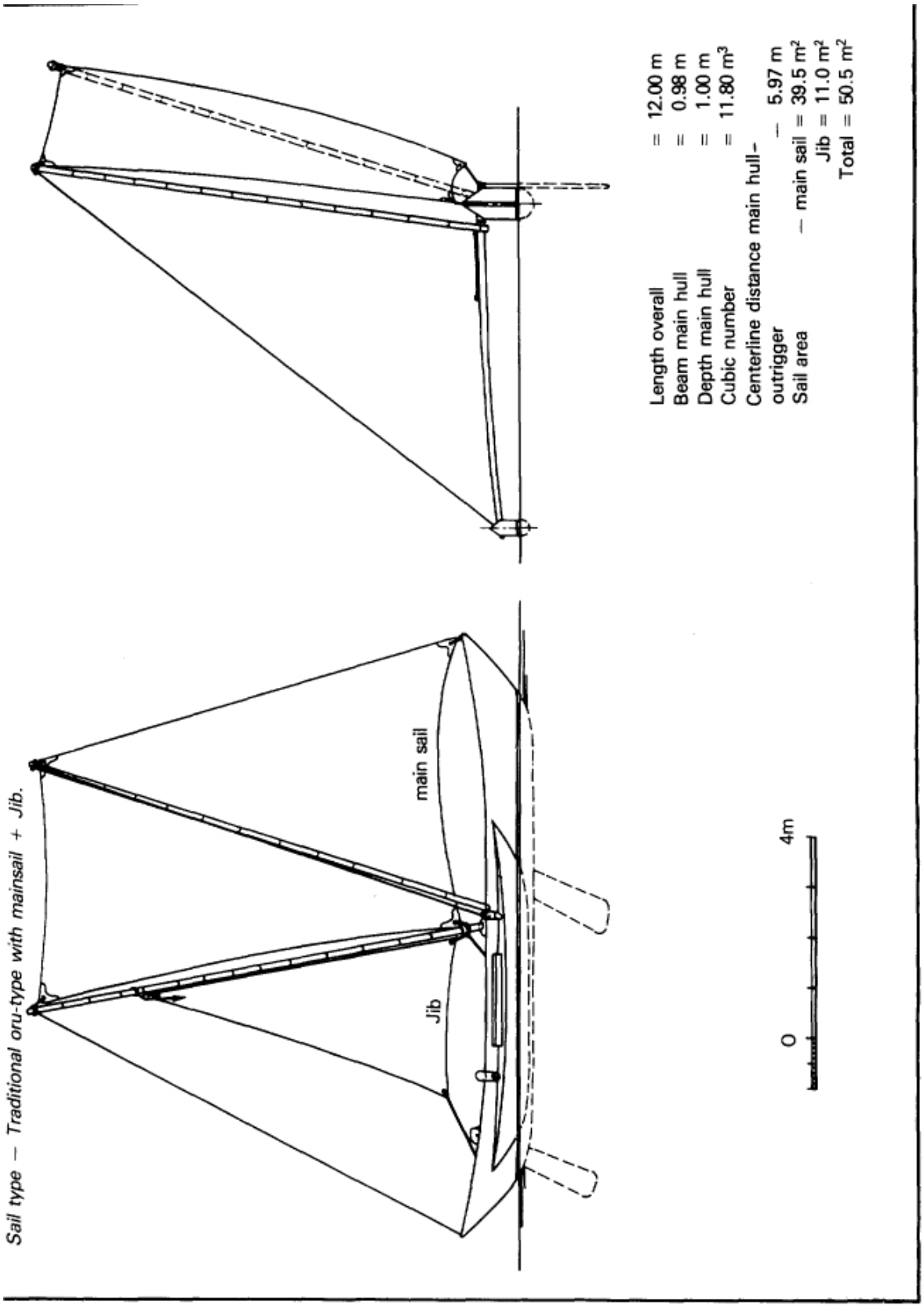
(Prototype for OBM propulsion)





Length overall	=	6.75 m
Beam hull	=	0.55 m
Depth hull	=	0.68 m
Cubic number	=	2.5 m^3
Beam overall	=	3.0 m
Engine : Outboard	=	6 hp


Sail type — Traditional oru-type with mainsail + Jib.
main sail
Jib
0
4m
Length overall = 12.00 m
Beam main hull = 0.98 m
Depth main hull = 1.00 m
Cubic number = 11.80 m³
Centerline distance main hull - outrigger — 5.97 m
Sail area — main sail = 39.5 m²
Jib = 11.0 m²
Total = 50.5 m²

Appendix 10

CATCH RECORD OF 12m FRP OUTRIGGER CANOE

Year/Month		No. of fishing trips	Value (Rs.) of catch	Average catch value/ fishing day
1982	Jan.	19	3242	170
	Feb.	19	4680	246
	March	18	2304	128
	April	20	2926	146
	May	16	2747	171
	June	10	1362	136
	July	16	2597	162
	August	17	3948	232
	Sept.	14	2730	195
	Oct.	18	2680	148
	Nov.	6	1050	175
	Dec.	22	7580	344
1983	Jan.	17	5925	348
	Feb.	23	7310	317
	March	21	3400	161
	April	23	3075	133
	May	24	1905	79
	June	20	3130	156
	August	14	2850	203
	Sept.	20	2230	111
	Oct.	19	2510	132
	Nov.	IS	1737	116
	Dec.	3	210	70
1984	Jan.	22	2500	113
	Feb.	14	1665	119
	May	10	1430	143
	June	14	1630	116
	July	16	3295	206
	August	26	5415	208
	Sept.	24	3300	138
	Oct.	24	6075	253
	Nov.	3	350	117
	Dec.	10	1325	133
1985	Jan.	21	2545	121
	Feb.	21	2405	115
	March	23	2010	87
	April	6	390	65
Total		628	106463	
Average		17 Days/Month	2877 Value/Month	170

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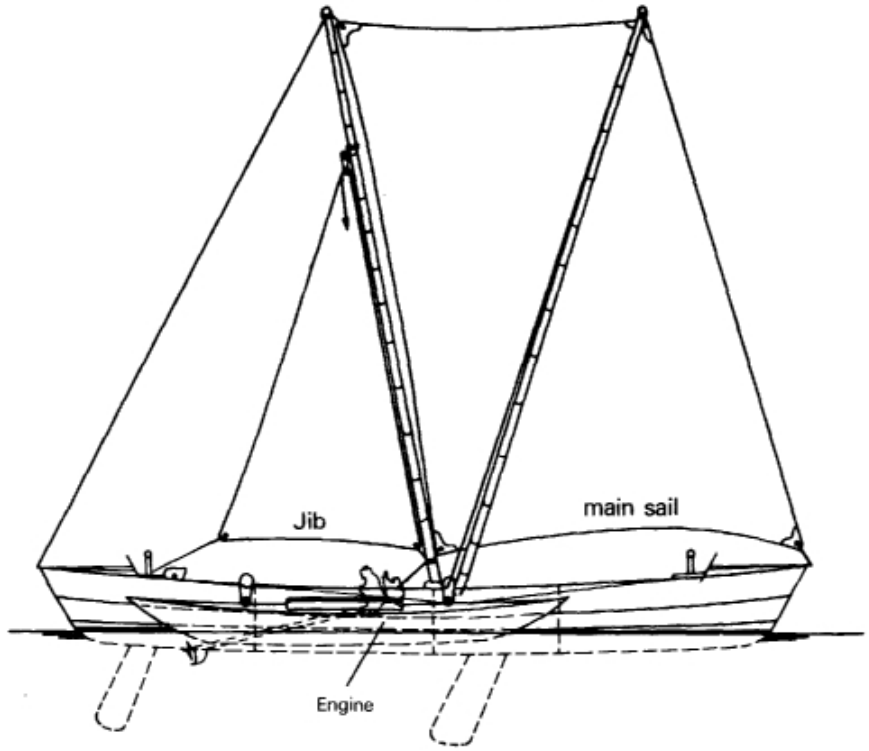
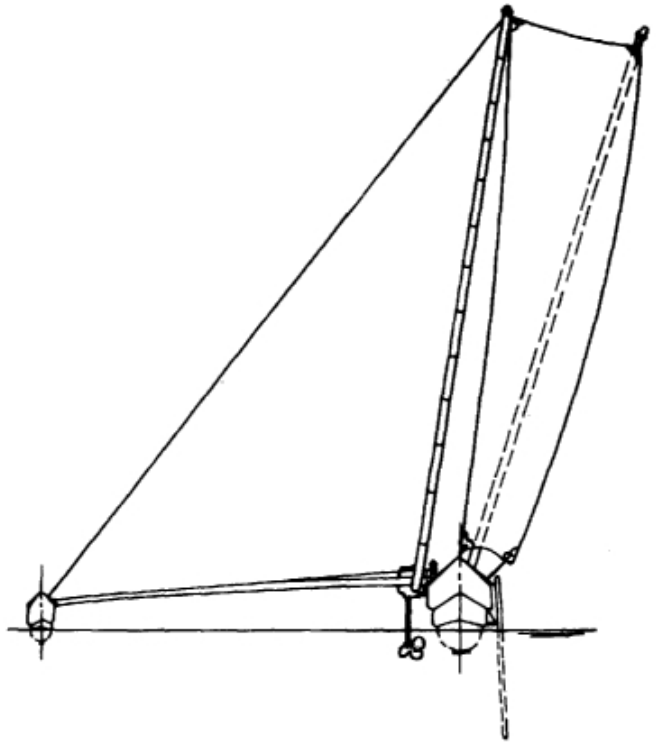
12 m FRP ORU WITH LONGTAIL ENGINE

Sail type — Traditional oru-type with mainsail + Jib.





Length overall	=	12.00 m
Beam main hull	=	0.98 m
Depth main hull	=	1.00 m
Cubic number	=	11.80 m^3
Centreline distance main hull-outrigger	=	5.97 m
Engine	7 hp Diesel (With long tail)	
Sail area main sail	=	39.5 m^2
Uib	=	11.0 m^2
Total	=	50.5 m^2

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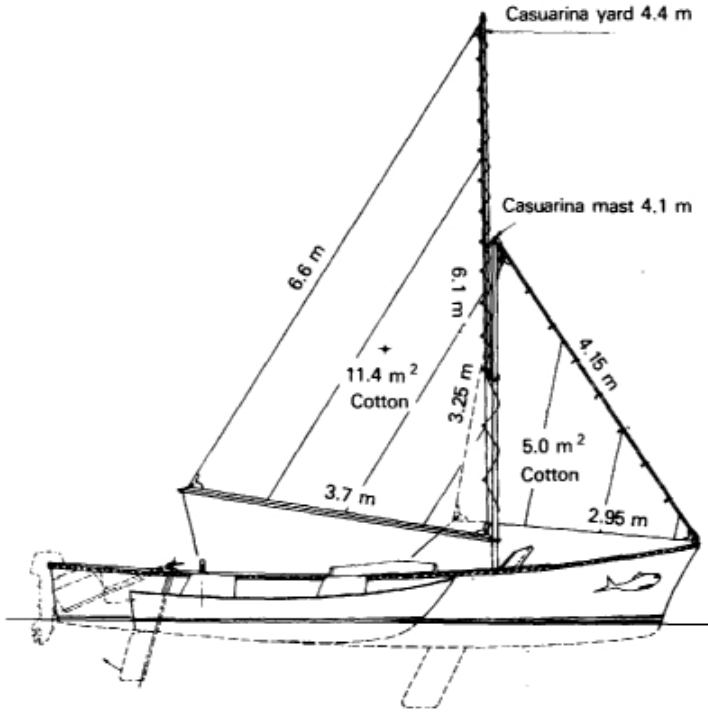
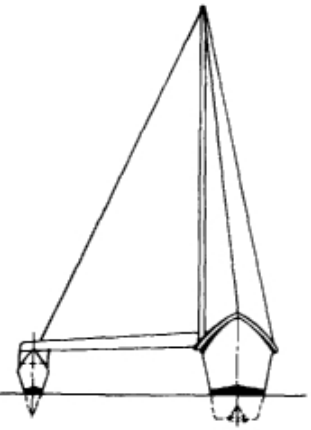
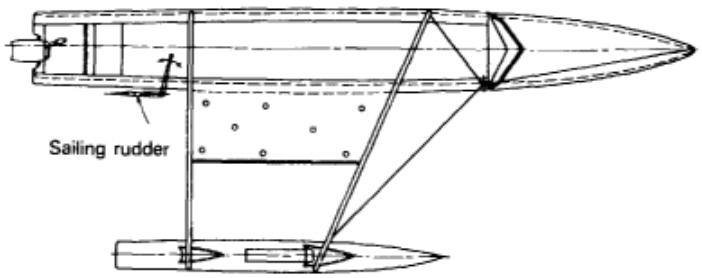
SRL-17, PLYWOOD OUTRIGGER CANOE







LOA	: 8.0 m
BEAM MAIN HULL	: 0.94 m
DEPTH MAIN HULL	: 0.86 m
CENTRE DISTANCE	: MAIN HULL TO OUTRIGGER — 2.30 m

Empty boat	—	540 kg
Engine & fuel	—	50 kg
Mast & sail rigging	—	35 kg
Lee board & sail rubber	—	25 kg
+ 2 Crew	—	125 kg
+ Nets	—	200 kg
Total		970 kg

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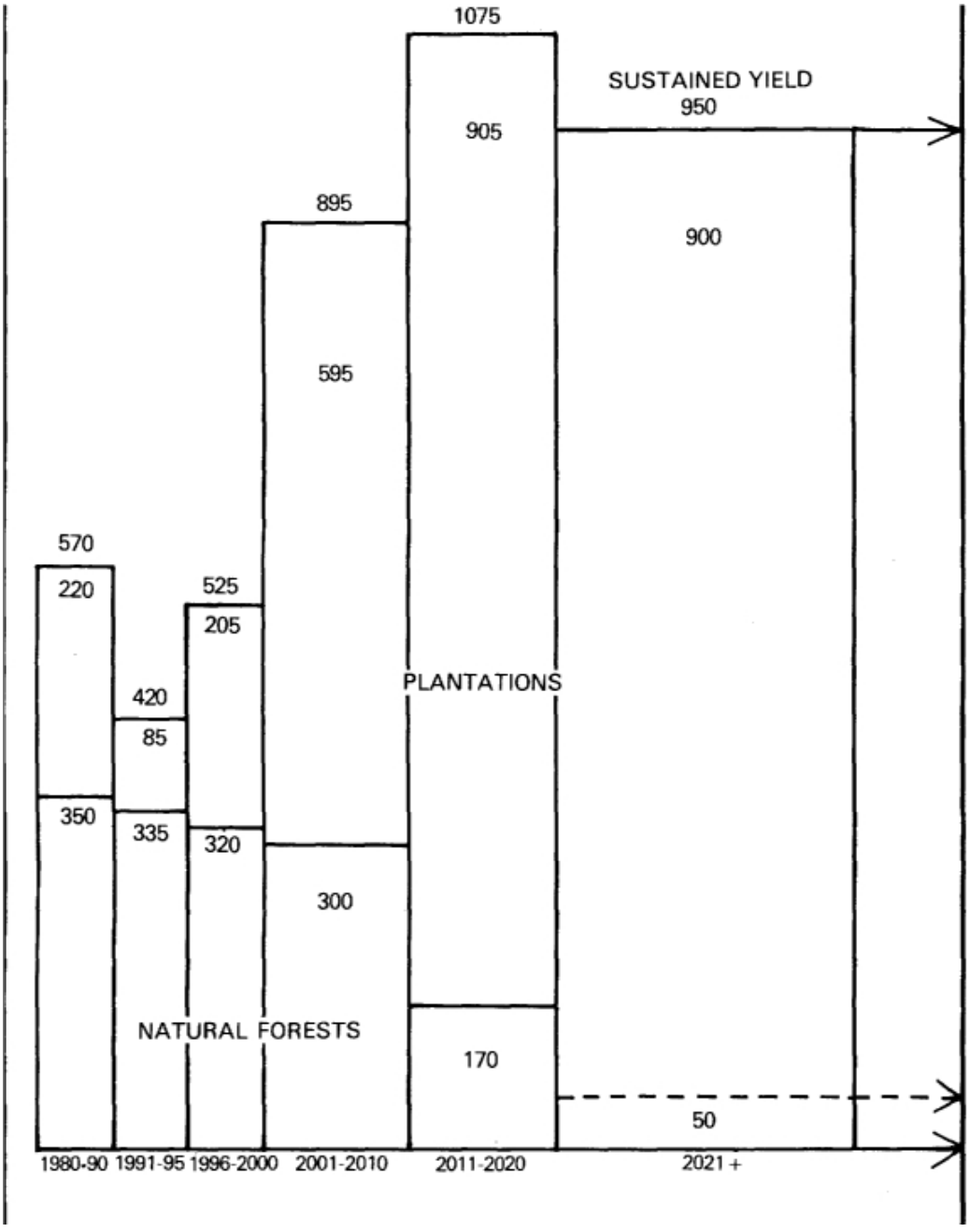
PROJECTED AVERAGE ANNUAL LOG SUPPLY FROM NATURAL FOREST, EXISTING AND FUTURE PLANTATIONS (1000 m3 SOLID OVERBARK PER ANNUM)



1) **Plantations** : **based on a stabilized area of 135,500 ha**
Nat. Forest : **based on a stabilized area of** 47,500 ha

From : **Ministry of Lands and Land Development**
FORESTRY MASTER PLAN FOR SRI LANKA

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Appendix 14

TIMBER FOR PLANKED CANOE CONSTRUCTION

Sinhalese Name	Scientific Name	Weight at 12% MC kg/rn3	Natural Durability	Shape retention as % of teak	Avatlability	Approx. price sawn. Nov. 1989 Rs./sq.ft. 1'' thick	Rs./m^3
Bedi del Wel del Gan del	*Artocarpus nobifis*	600	High	n.a.	Medium	28	4030
Mara Paramara	*Albizzia odoratissitma*	635	Moderate	80	Medium	na.	n.a.
Domba	*Calophyllum inophylluin*	*650*	Moderate	n.a.	High	22	3170
Etamba	*Mangifera zeylanica*	650	Low	95	High	10	1440
Amba	*Mangifera indica*	650	Low	95	High	10	1440

Note MC = Moisture Content.

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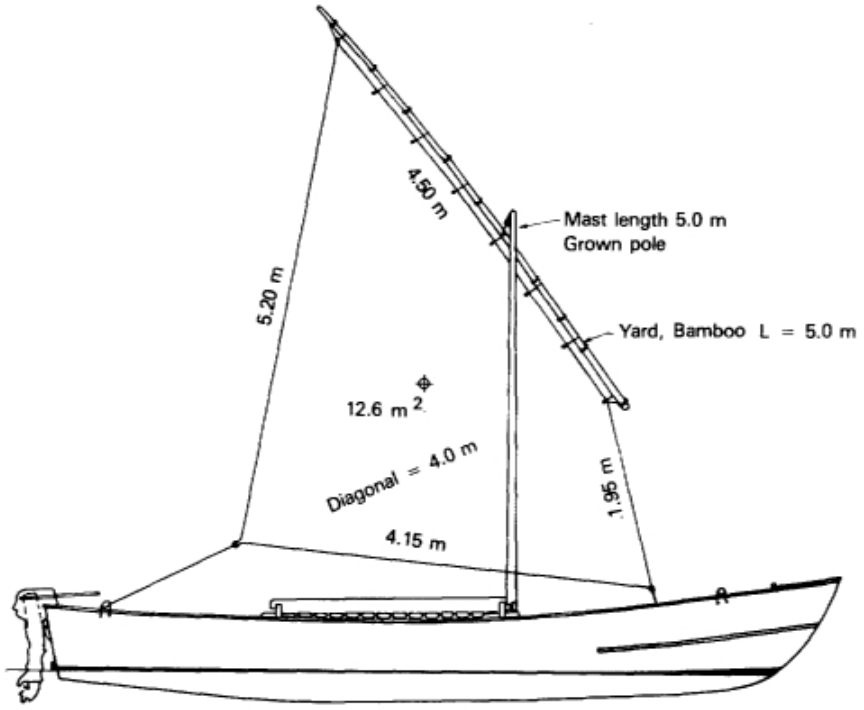
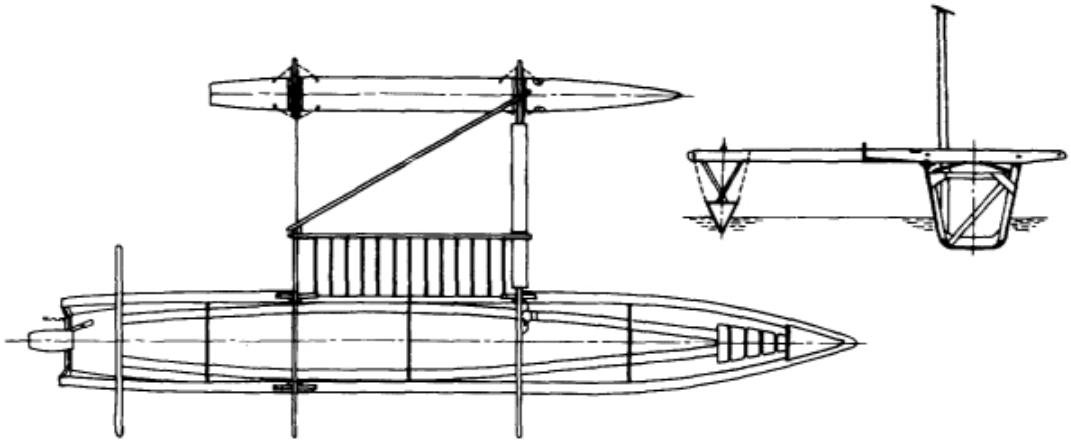
8 m OUTRIGGER CANOE, SRL-18





		Main hull	Outrigger
Length overall	*LOA*	8.0 m	4.9 m
Length waterline	*L*	7.2 m	4.3 m
Beam moulded	*BMD*	0.48 m	0.35 m
Depth moulded	*DMD*	0.83 m	0.37 m
Draft	*T*	0.29 m	0.20 m
Cubic No.		6.5 m^3	0.63 m^3
Weight Empty		460 kg	80 kg
Displacement		930 kg	90 kg
Engine 7 hp. Outboard			

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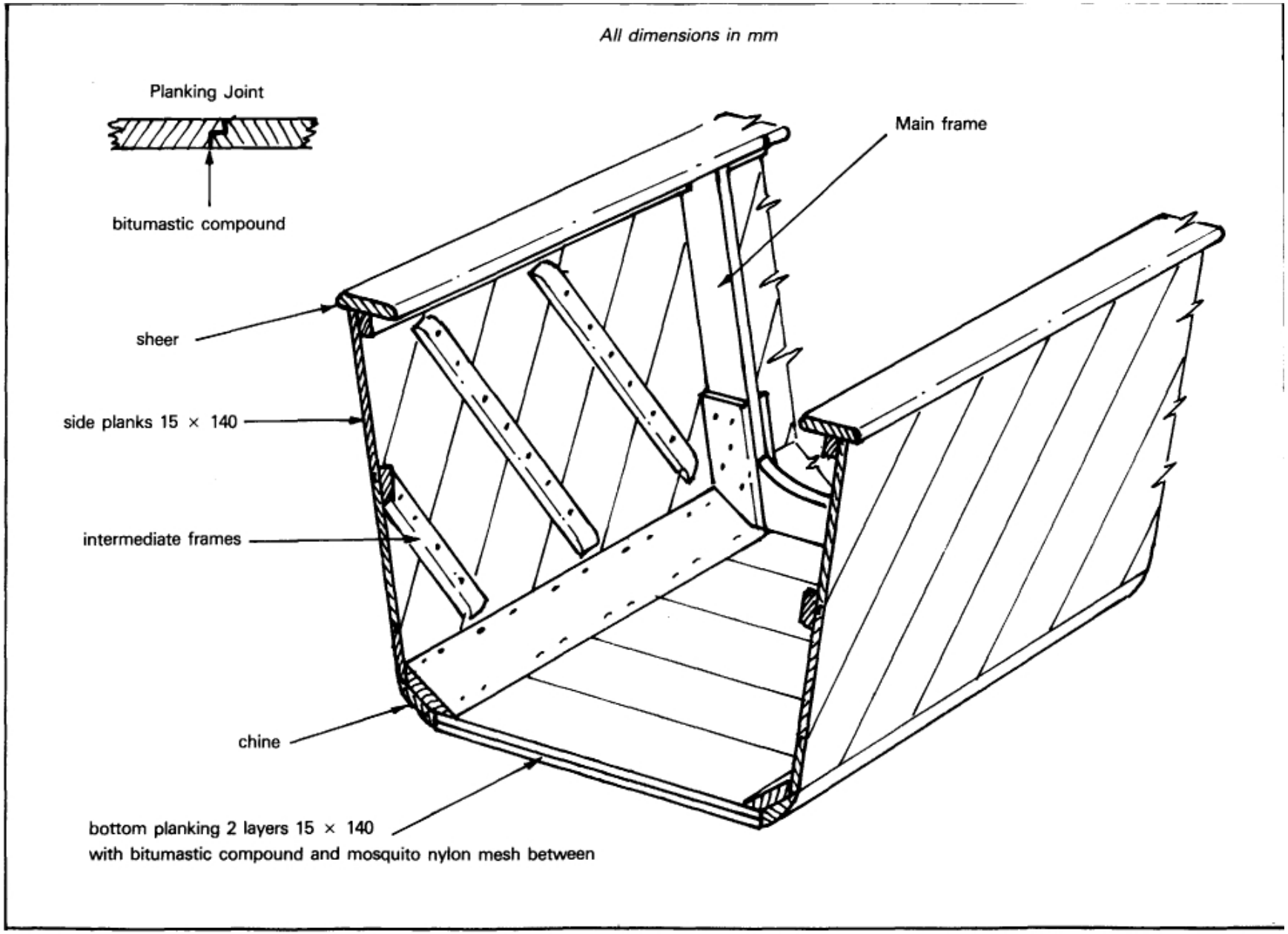
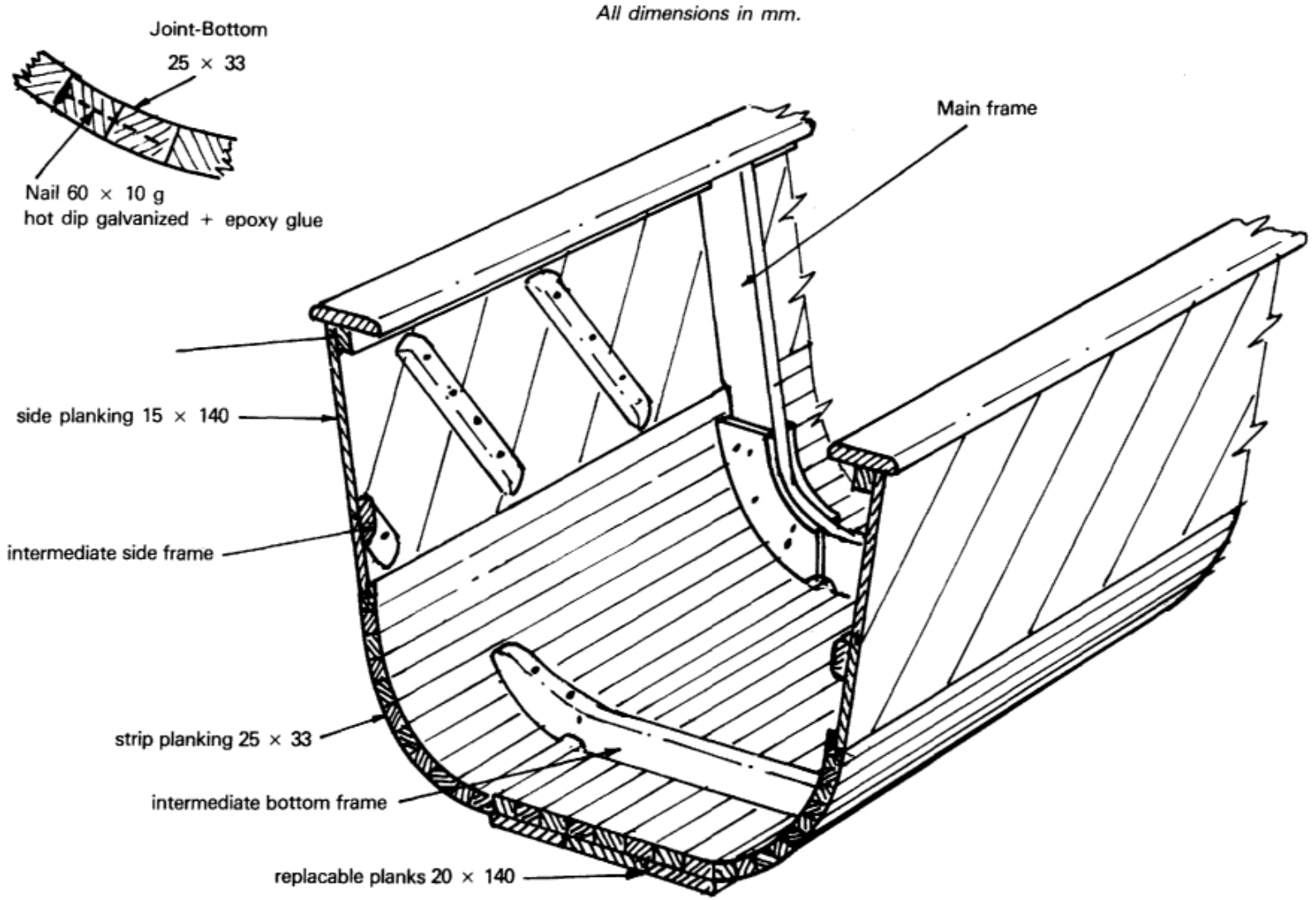

All dimensions in mm
Planking Joint
bitumastic compound
Main frame
sheer
side planks 15 × 140
intermediate frames
chine
bottom planking 2 layers 15 × 140
with bitumastic compound and mosquito nylon mesh between


All dimensions in mm.
Joint-Bottom
25 × 33
Nail 60 × 10 g
hot dip galvanized + epoxy glue
Main frame
side planking 15 × 140
intermediate side frame
strip planking 25 × 33
intermediate bottom frame
replacable planks 20 × 140

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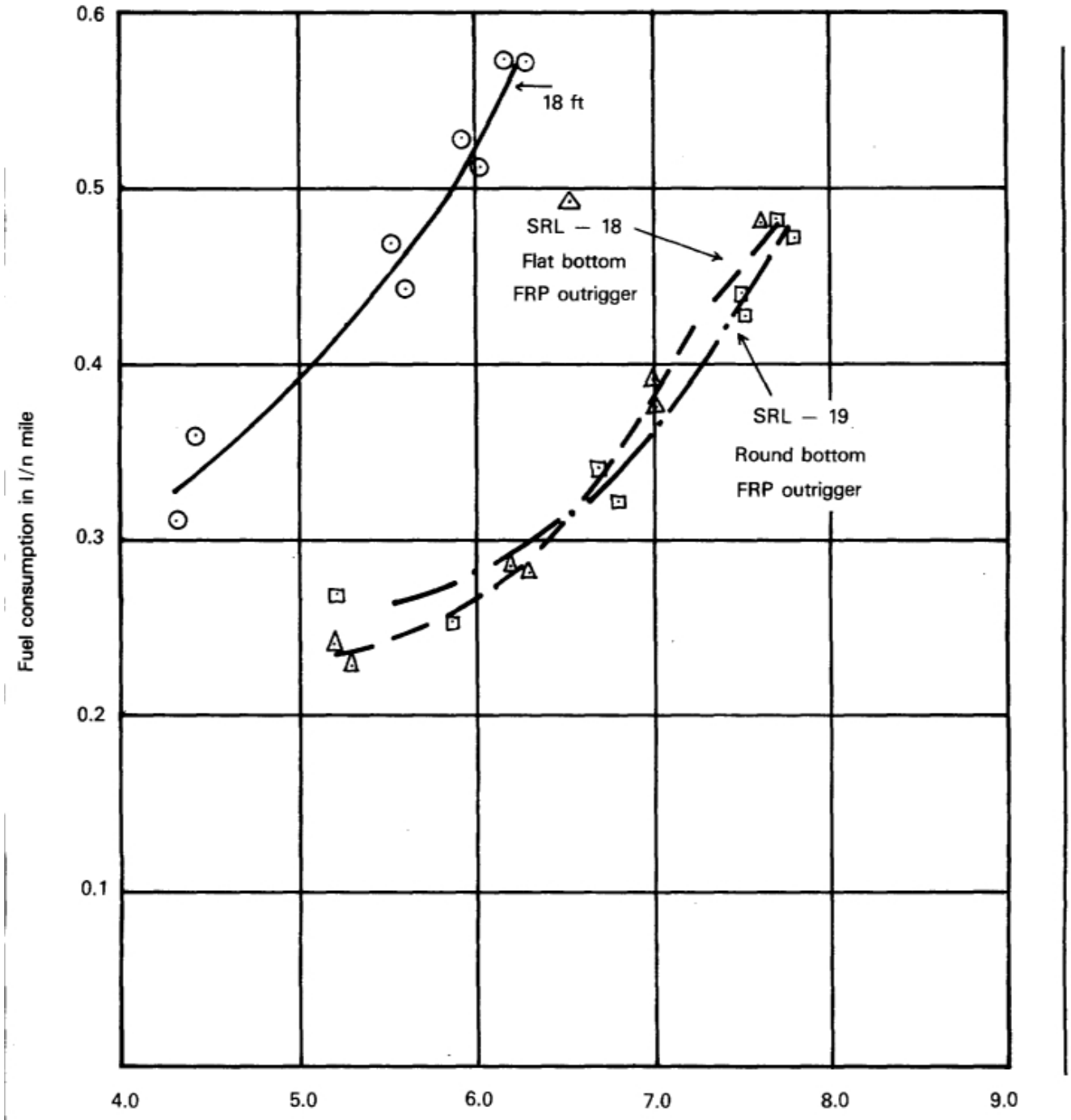
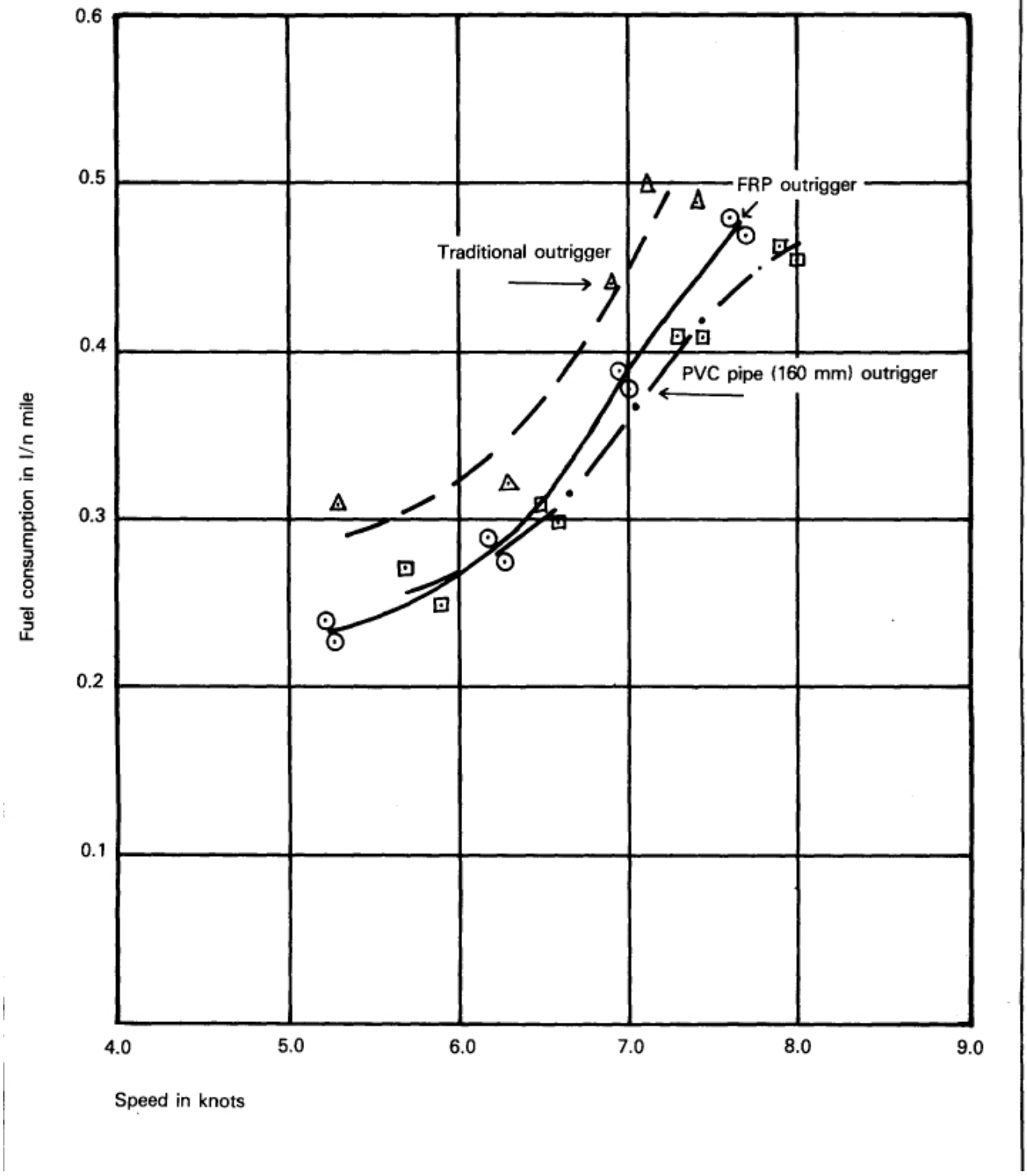
SPEED AND FUEL CONSUMPTION TESTS: 18-FT BOAT AND OUTRIGGER CANOES SRL-18, SRL-19



Fuel consumption and speed tests made with same engine : Yamaha E 8DK (7 hp Kerosene)
Prop : 9'' × 5¾'' and with same load = 6 men (400 kg.)

SPEED AND FUEL CONSUMPTION TESTS:
OUTRIGGER CANOE SRL-18 WITH DIFFERENT OUTRIGGERS



All outriggers spaced at 2.50 m centreline boat to centreline outrigger
Engine : Yamaha E 80K, 7hp Kerosene. Prop : 9" x **53/i"**

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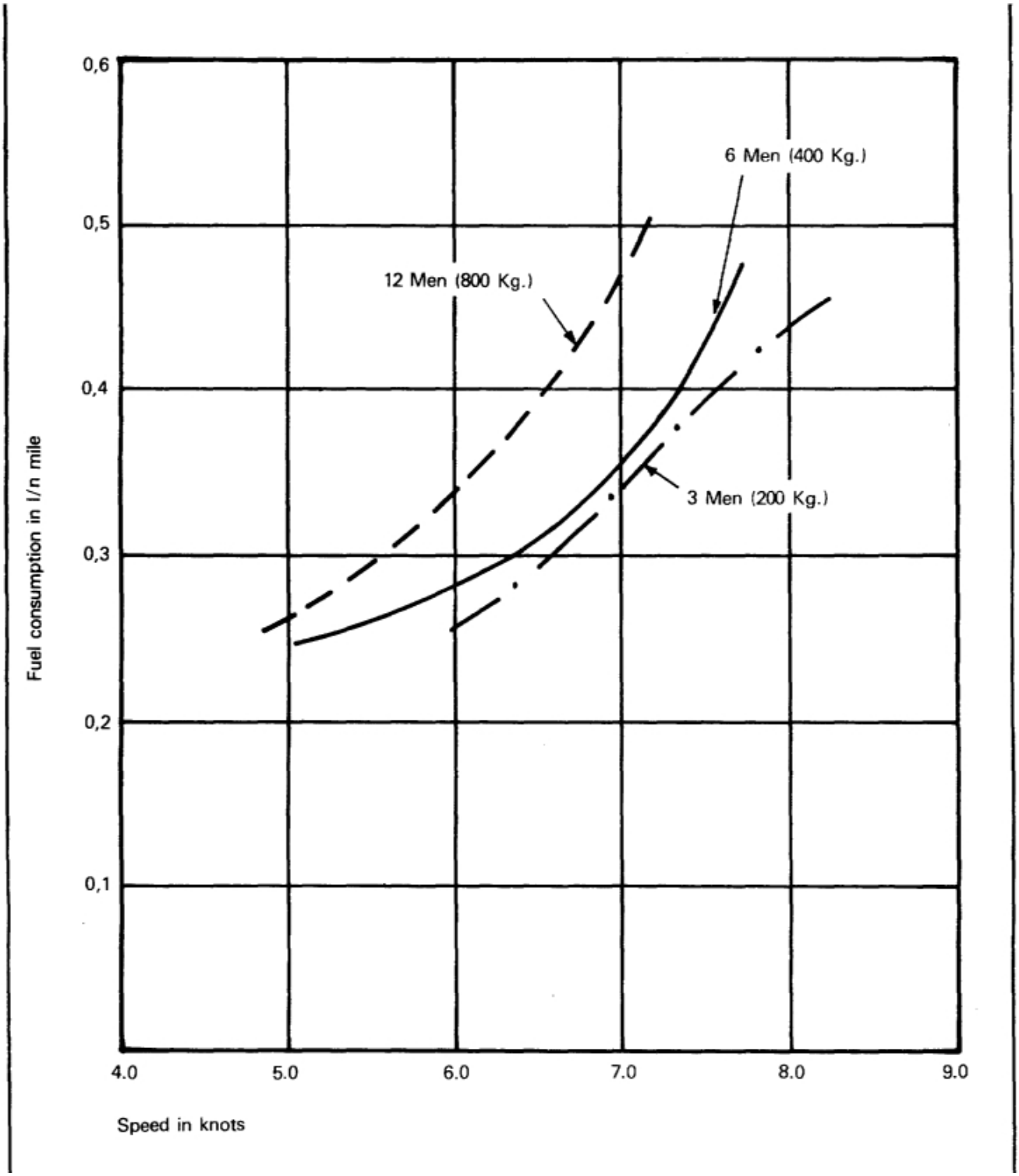
Appendix 18c

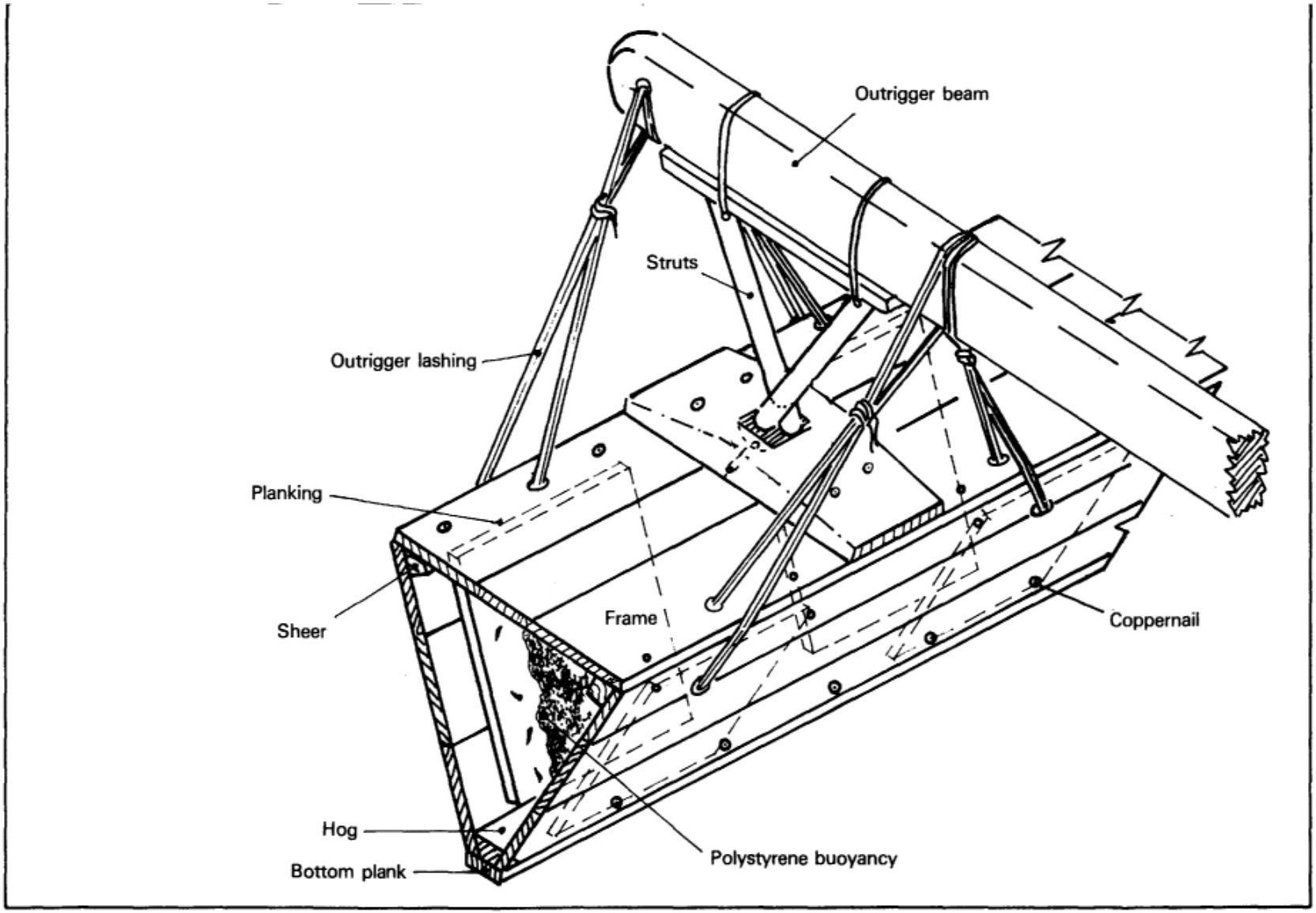
SPEED AND FUEL CONSUMPTION TESTS: OUTRIGGER CANOE SRL-19 WITH DIFFERENT LOADS



Engine : Yamaha E 8DK, 7hp, Prop : 9" c 5%"

<<

PLANK OUTRIGGER



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Appendix 20

PRODUCTION DATA AND CASH FLOW FOR SRL-18

PRODUCTION	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Total	Av/ month
* Number of fishing days	17	11	14	10	16	16	21	31	24	21	17	10	208	17
* Number of mandays	51	33	45	30	48	96	126	186	144	126	90	30	1,005	84
* Total catch (kg)	389	420	450	382	538	540	1,002	1,670	585	685	185	189	7,035	586
W/gillnet	389	420	350	382	538	30					108	189	2,406	201
W/ring net			100			510	1,002	1,670	585	685	77		4,629	386
* Average catch per day (kg)	23	38	32	38	34	34	48	54	24	3311		19	34	n/a

CASH FLOW *(in SRL rupees)*	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Total	Av/ month
(I) Total sales	8,200	6,720	7,260	*6,450*	8,400	10,710	20,070	35,925	13,000	15,000	3,710	3,957	139,402	11,617
(2) Variable operating items : Fuel (Kerosene)	l,280	954	1,140	676	1,472	1,640	1,984	2,734	1,896	1,688	1,264	830	17,558	1,463
Petrol	0	0	0	150	262	0	315	495	360	315	*255*	*150*	2,302	192
Kerosene/Lamp	0	0	0	321	21		0	0	0	0	91	0	433	36
Food	1,200	795	990	785	575	715	650	950	730	630	665	725	9,410	784
Other expenses	761	462	590	150	0	275	16	80	47	26	0	308	2,715	226
Total (2)	3,241	2,211	2,720	2,082	2,330	2,630	2,965	4,259	3,033	2,659	2,275	2,013	32,418	2,702
(3) Net cash flow before payment to crew and boat owner	4,959	4,509	4,540	4,368	6,070	8,080	17,105	31,666	9,967	12,341	1,435	1,944	106,984	8,915
(4) Distribution of net cash flow:														
* Crew members *(50%)*	2,480	2,255	2,270	2,184	3,035	4,040	*8,553*	15,833	4,984	6,171	718	972	53,492	4,458
Gross payment boat owner **(50%)**	2,480	2,255	2,270	2,184	3,035	4,040	8,553	15,833	4,984	6,171	718	972	53,492	*4,458*
Repairs	808	808	808	808	808	808	808	808	808	808	808	808	9,700	808
Insurance	172	172	172	172	172	172	172	172	172	172	172	172	2,068	172
* Net payment boat owner	1,499.	1,274	1,289	1,203	2,054	3,059	7,572	14,852	4,003	5,190	(263)	(9)	41,724	3,477
(5) Payment/man-day	49	68	50	73	63	42	68	85	35	49	8	32	n/a	53
Payment/man-month	827	752	706	728	1,012	673	1,425	2,639	831	1,028	136	324	n/a	923

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32. **Bank Credit for Artisanal Marine Fisherfolk of Orissa, India. U. Tietze. Madras, India,** May **1987.**
33. **Non-formal Primary Education for Children of Marine Fisherfolk in Orissa, India. U. Tietze, Namita Ray. Madras, India, December 1987.**
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37. **High-opening Bottom Trawling in Tamil Nadu, Gujarat and Orissa,** India : **A Summary of Effort and Impact. Madras, tndia, February 1987.**

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38. Report of the Eleventh Meeting of the Advisory Committee. Bangkok, Thailand, March 26-29, 1987. Madras, India, June 1987.

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