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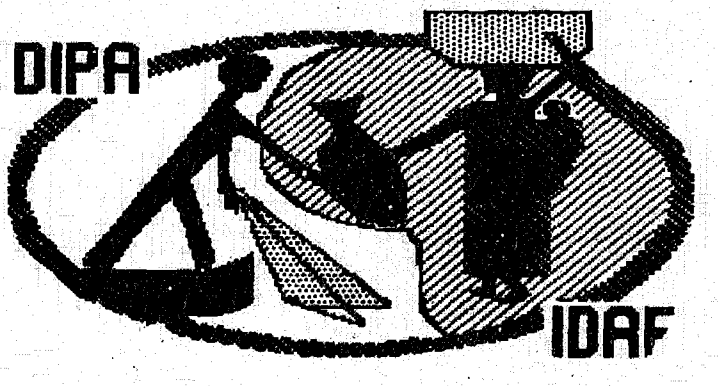

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DESIGN AND TRIAL OF SAILING RIGS FOR ARTISANAL FISHERIES OF SIERRA LEONE

based on the work of
S.J. Akester

Programme de Développement Intégré des Pêches Artisanales en Afrique de l'Ouest - DIPA

Programme for Integrated Development of Artisanal Fisheries in West Africa - IDAF

GCP/RAF/192/DEN - GCP/RAF/198/DEN
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With financial assistance from Denmark and Norway, and in collaboration with the Peoples Republic of Benin, the Fisheries Department of FAO is implementing in West Africa a programme of small scale fisheries development, commonly called the IDAF Project. This programme is based upon an integrated approach, involving production, processing and marketing of fish, and related activities; it also involves, in particular, an active and full participation of the target fishing communities.

This report is a working paper and the conclusions and recommendations are those considered appropriate at the time of preparation. The working papers have not necessarily been cleared for publication by the government(s) concerned nor by FAO. They may be modified in the light of further knowledge gained at subsequent stages of the Project and issued later in other series.

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C O N T E N T S

1. INTRODUCTION

FAO/UNDP Project SIL/82/015 commenced in early 1985. The Project aims to improve the standard of living of fishermen and the fishing communities in the Shenge area of the Kargboro Chiefdom.

From initial frame surveys carried out by the Project, it was apparent that the overall fishing effort of the area is declining, one of the principal reasons for the decline being the high cost and problems of supply of fuel and engine spare parts to this remote region.

The Project requested assistance with the introduction of improved sail technology to assist both motorised vessels with fuel saving and the improvement of performance and safety of the traditional small craft using sail.

The consultant spent one month in Sierra Leone during which Project staff and local tailors and carpenters were instructed in techniques of manufacturing sails and rigging from locally available materials.

A sail of the Delta or crab claw type was made and trialled on a 7 metre canoe. The craft was also fitted with an outrigger. A ketch rig consisting of a gaff mainsail and gunter mizzen was made and trialled on a 15 metre Ghana type canoe.

Both craft were sailed and performance data gathered using instruments. The consultant conducted fishing trials with both craft to assess the practical value of the modifications to the method of operation. Recommendations for future activities and follow up work by Project staff are made.

2. FAO/UNDP FISHERIES PROJECT SIL/82/015

The Project was established in early 1985, originally for a one year pilot operation. This has now been extended to a three year Project.

The Project's aim is to improve the standard of living of the fishing communities of Shengebole, Katta, Shenge, Plantain Island, Patti, Tissana, Bendu, Thumba, Sonway, Mano, Baoma, and Bompetoke. These communities are all supported by the artisanal fishery. The Project is identifying constraints in all aspects of the fishery and implementing improvements through both direct action and the formation of community groups and cooperatives.

The Project has a team leader/master fisherman, counterpart manager, administrative officer, boatbuilder, sociologist and fishermen. A visiting economist is currently conducting a survey of fish marketing. The Project has had consultancy assistance in Community Development for women fish processors, Project Management, Credit and Revolving Fund Administration, and the use of sail power for fuel economy. The Project has two Peace Corps Volunteers.

In this first phase, the Project is conducting frame surveys of the fishery and collecting information on all aspects of the life of the communities. In the next two years, the Project will seek to implement improvements agreed by the communities in Fishing Technology, Fish Processing and Marketing, and the establishment of cooperatives.

The Project is based at Shenge, the traditional administrative centre of the coastal Kargboro Chiefdom, and seat of the Paramount Chief. A project office is operational in rented accommodation, a site for the Fisheries Project building has been agreed, and construction is expected to be completed in early 1986.

Shenge is in a remote part of the country, 290 kms from Freetown, of which only the first 110 kms is paved road. The road via Moyamba to Shenge from the main road is in poor condition and receives little maintenance. Shenge is served by only one passenger vehicle of 1.5 tons which makes the journey to Moyamba several times a week. In the rain months the road is often not passable except to 4-wheel drive vehicles.

Alternative communication is by passenger vessel across Yawri Bay to Tombo on the south side of the Freetown peninsular. From Tombo commercial vehicle transport is usually obtainable to Freetown. Both sea and road transport is expensive and unreliable, thus all materials required for the fishery such as fuel and fishing gear are expensive, and transport costs of fish to market reduces margins for the fishing communities who are reliant on a few traders who have a monopoly.

The Project has had an early impact by sponsoring a local businessman to establish a retail outlet for petrol.

Shenge has a dispensary with two nurses, a secondary and primary school, and a Police post. Water supply is from wells, there is no organised sanitation, and no electricity. Population of the Project area is estimated at 5,500. The Kargboro chiefdom population is estimated at 45,000. Shenge itself has approximately 500 people.

3. FISHERIES, SIERRA LEONE.

3.1. General

The coast line of Sierra Leone is approximately 570 kms and is indented by many islands and estuaries. The continental shelf varies in width from 32 kms at the southern border with Liberia, to 140 kms at the northern border with Guinea Conakry. Total shelf area is estimated at 24,800 sq.km.

The two major currents on the continental shelf are the Canary and Benguela. The Canary current flows in a southerly direction down the coast to 5 deg. north, off the southern Liberian coast, then westwards. The Benguela current moves northwards until about 10 deg. south where it also moves westwards. Between these two flows the Equatorial counter current bringing warm water onto the shelf of Sierra Leone. Coastal waters vary considerably in salinity owing to the large outflow of rain water from the many estuaries during the rain months.

Fish production of Sierra Leone is compared with neighbouring countries - Source, CECAF/84/58 Tech.

Table 1.

In '000 Metric Tonnes

	Tuna	Crust.	Dem.	Ceph.	Mack.	S.Pel.	Mix	TOTAL	Value US$
Senegal	3.0	5.0	50.0	3.0	8.0	90.0	31.0	190.0	91.8
Gambia		0.5	0.5			6.0	3.5	10.5	4.7
G. Bissau		1.5	1.5				2.5	5.5	9.6
G. Conakry						12.5	5.0	17.5	3.0
S. Leone		1.0	4.0			30.0	5.0	40.0	12.7
Liberia		0.5	3.0			4.0	5.0	12.5	6.5
Ivory Coast	15.0	0.5	15.0			30.0	6.5	67.5	31.9
Ghana	25.0	0.5	30.0		10.0	90.0	40.0	195.5	71.5

3.2. Fish Species

The most commonly caught species in Sierra Leone waters are the small pelagics - Bonga, Sardinella, Mackerels, demersal fish of the Croaker fauna - Croaker (Sciaenidae), Grunters (Pomadasyidae), Spadefish (Drepanidae), Threadfin (Polynemidae), and Soles (Cynoglessidae). Snapper fauna caught on the rocky areas of the continental shelf mainly consist of sea breams (Sparidae), Snappers (Lutjanidae), Groupers (Serranidae) and Gurnards (Triglidae) (source CECAF). In low salinity waters there are larger Croakers (Pseudotolithus) and Catfish (Arius spp).

3.3. Fish Resources

The most abundant species landed are Bonga (Ethmalosa fimbriata) which is estimated to form 50% of the artisanal fish landings. Small bonga of less than 210 mm, locally known as Awefu, are now forming a larger proportion of the Bonga landings than in 1981 (Fisheries Department statistics). Seasonal migrations of Bonga are associated with salinity changes. During the rain season, Bonga is spread out over wide areas and low catches are recorded. The concentration of the fish into schools in the dry season allow greater catches by the ring net fishermen.

FAO estimates maximum sustainable yield for Pelagic species at 80,000 tonnes annually. Other species which make up the Pelagic stocks are herring (Sardinella maderensis) and the Lati (Ilisha africana). A fish catch assessment programme in Sierra Leone is organised by the Fisheries Division in Freetown. The section dealing with fish statistics are ill equipped to monitor the field work of its staff. Fish catch statistics are therefore irregular and generally regarded as indicative.

Before 1955, all fishing effort was artisanal. In 1942, total fish catch was estimated at 4,500 tonnes which rose to an estimated 33,600 tonnes in 1967, but fell to an estimated 23,000 tonnes in 1970, probably due to the expulsion of 2,000 Ghanaian fishermen in 1967-8 (Source CECAF).

Fish landings recorded in 1975 were 68,500 tonnes. This figure fell to 50,000 tonnes in 1980 and estimates for 1983 indicate a further fall to 40,000 tonnes. An estimated 50,000 tonnes of fish are reportedly exported direct from Sierra Leone waters by industrial fishing vessels.

Fish catching methods in use by artisanal fishermen are little changed over the last 30 years. The use of nylon netting and the outboard engine have made the methods more efficient in catching, but they are still set in their ways. Little fishing effort has been directed at demersal species, sharks or crustacea.

3.4. Fisheries, Shenge Region

The population of the fishing communities is mixed between the indigenous Sherbro people and the Temne tribe from northern Sierra Leone who have settled in the region since the 1930's. The Sherbro are predominently subsistence farmers and fishermen, very few are engaged in regular fishing on any scale, they mostly operate one man dug-out Kru canoes, hook and line fishing.

The Temne are moslem and operate their fishing vessels and fish processing through the extended family system. Ring netting and the use of the so-called Ghana boats was learnt from the travelling Ghanaian fishermen who employed Temne crews to operate their boats.

Standard 1 - 3 and 3 - 5 boats are operated from all the fishing communities and have been increasing in numbers in recent years. Those operating from Katta have a distinct drift netting method which uses the available winds to best advantage. The boats leave Katta in the late afternoon when the sea breeze is gaining strength and paddle to windward towards Shenge Point. Under the lee of the Point they set their sails and reach out into the Yawri Bay. The fleet stay together and set their drift nets between two and four miles from shore. The nets are generally 400 metres headline length and 6 metres deep. Mesh sizes vary between 2.5 and 4 cms stretch mesh. The nets are left down until dark, usually less than one hour, then hauled and sail set to return to Katta before the sea breeze is finished around 21.00 hours. The nets are cleared on return to the beach and the operation repeated the next day. Catches are mainly Bonga and vary between 20 and 100 kgs. per day.

Standard boats operating on the other side of Shenge Point to the south operate a similar system but also do day time fishing with longer nets using them as encircling nets set around visible signs of fish schools.

The Ghana plank boats are operated by Temne fishermen. Boat owners use their extended family structure to assist with forming the crew and the work of processing and marketing the fish. The boat owners are important people in the fishing communities, with much social standing. They house and feed their crews and families and look after their interests. A clearer picture of the economic structure of the Ghana boat operation is needed to ascertain the profitability of the present system. Some boats are clearly doing well but others are not and the number of boats operational is falling.

The boat owners operate a kind of welfare system. Therefore crew remuneration is not directly financial, some processing and marketing is carried out within the families, but regular customers of the boat also receive fish.

The fish catch pattern is not stable. In times of poor catches, boats may prospect for fish all day without shooting the net, burning expensive fuel for no reward. When catches are good, schools of fish are often available within two or three miles of the villages, so that fuel costs are low. However plentiful supplies of fish reduce the catch value.

Most Ghana plank boats in the Shenge region are operated from Plantain Island and Katta, mainly fishing in Yawri Bay, which is shallow (mostly less than 15 metres) and has a mainly soft mud bottom. The ring nets are mostly 850 metres headline length and 30 - 35 metres deep, therefore the lower part of the net is sweeping the bottom.

Kru canoes carry out hand lining within one to two miles of the shore in areas with rocky bottom for demersal fish.

Fishing craft in use in the region are divided into distinct groups, as follows:

- Kru, or one man canoes, of 5 - 6 metres LOA made from dug-out logs and operating close inshore with hooks and lines. Paddled or sailed, using three cornered sail set on bamboo spars.

- Standard 1 - 3 man canoe, of 6 - 7 metres LOA. May be dug out from large logs or planked, operating in coastal waters with hooks and lines, or drift nets. Paddled or sailed using three cornered sail set on bamboo spars.

- Standard 3 - 5 man canoe of 7 - 8 metres LOA. Planked construction, operating in coastal waters with drift nets or encircling nets. Paddled or sailed with square sail, occasionally motorised, with outboard engines.

- Ghana Boat of 10 - 18 metres LOA. Planked construction, operating in coastal waters using ring net of 850 metres headline length with crews of 14 to 20 men. Originally paddled by large crews, now all motorised with outboard engines ranging in h.p. from 25 to 40.

Table 2

	Kru	1-3	2-5	Ghana	Engine	1965 TOTAL	Total 1961	Fish-ermen	Popu-lation	Catch
Shengehole		18	4			22	24	85	305	
Katta		30	1	7	9	47	42	179	738	1088
Shenge	11	6	1			17	17	17	489	63
Plantain	2	19	11	23	14	69	50	393	1100	2080
Patti	6	16	2			24	10	22	203	127
Tissana	3	35	15	3	2	58	66	197	412	370
Bendu		24	9			33	39	60	180	558
Thumba		6				6	3	6	60	
Sunway		12				12	9	8	85	
Mano	—	7	9	8	2	26	28	158	603	
Boona		14	39	7	4	64	53	136	485	838
Bompetahe	4	33	20	6	6	69	38	71	736	641
Totals	22	221	111	64	37	449	379	1320	5450	5769
Totals 1961	11	173	122	72			379			

3.5. Fishing Craft

The traditional fishing craft of Sierra Leone is the dug-out canoe. They are still widespread and form the bulk of the country's artisanal fishing fleet.

Sierra Leone's more recent maritime history has a tradition of planked boat building dating from the late 19th Century. At this time, relatively sophisticated boats were being constructed under a training scheme run by the Elder Dempster Fishing line in order to train carpenters for ship repair work. 9 - 10 m. pulling boats were constructed by local joiners as part of the programme. Some of these boats found their way into the fishery around Freetown. No records are available as to how many were originally built but some thirty were still operating in 1945 and three still survive. The skills used to construct these so-called 'benefit' boats spread up and down the coast and are still evident.

With the exception of the 'benefit' boats, the majority of craft remained as dug-out canoes up to around 1930, when the Fante fishermen arrived from Ghana in large dug-out canoes up to 20 m. LOA. The fishing methods used by the Fante included ring nets for pelagic fish which was most successful and copied by local fishermen. However, logs of sufficient size to make these large dug-outs were not common in Sierra Leone and the local boat builders managed to copy them using planked construction.

The new Ghana plank boats were long and narrow beam, and could be paddled by the large net-handling crews at sufficient speed to encircle schools of fish. The plank boats could also be built more quickly than the dug-outs and demand escalated. Planked versions of smaller boats were also introduced and now this method is used in all but the smallest canoes.

The construction methods in use demonstrate the predominantly slight sea conditions prevailing, as these craft - even when new - cannot withstand pounding on a beach or even large wave action.

Boatbuilding

A typical boatbuilding squad consists of a master boatbuilder who controls one or more foremen. Each foreman in turn manages a building team of 3 to 6 apprentices. Apprentices may remain in training for many years.

The building squad may locate timber on behalf of a fisherman or boat owner or the squad may be presented with a timber stock built up over a period by a prospective owner. The search for suitable grown shapes for frame making may take considerable time and is a major constraint in new boat building.

When a new boat is to be built, the future owner will discuss the size, shape and construction method and price. During construction, the owner is wholly responsible for supplying all materials required as well as feeding and housing the building squad.

The price paid to the builder is for his services and may be in kind, such as fish or future services, or in cash. The system is flexible and dependant on the relationship between the parties and the social standing of the owner.

When all materials are on site, final selection takes place and this process determines the detailed shape of the future craft.

The keel is supplied by a specialist and is usually the heart of a mango tree bent into the desired rocker shape by weights and props. Grown frames are nailed to the keel, midship sections being doubled up across the top of the keel.

The sheer strake and garboard are fitted first, the latter roughly bevelled to butt against the keel, but no rebate is cut. Planks are often as wide as 400 mm and are not planned, with often many planks butting on the same frame. Butt straps are not used.

Mast timber used is freshly cut and considerable shrinkage occurs even during the 2 - 3 weeks of construction time for 16 - 18 metre vessels.

Most boats have small fore and aft decks and 300 mm. thwarts at 1.5 m. spacing the length of the boat. An outboard well (bracket) is installed between frames on the starboard quarter made up of short lengths of planking, edge fastened.

Costings for a 16 metre Ghana boat are approximately as follows:

	Le.
Frames	1,000
Keel, 2 + lengths + stem and stern posts	300
Planks, 120 planks at Le. 32 each	3,840
Thwarts	320
Gunwhale capping and stringer	220
Wire nails, 40 kg. at Le 12.	480
Oakum, 10 kg at Le.25	250
Putty, 30 kg. at Le. 22.50	675
Labour, negotiated fee	1500
Subsistence, approx. Le.5/man/day	750
Total	Le.9335

Standard 3 - 5 boats up to 8 m. LOA cost in the region of Le.5000. There are many possibilities for reducing the cash investment in the construction of a fishing craft, however, these economies may have social implications which can be onerous.

4. WEATHER AND SEA CONDITIONS

Offshore winds of Sierra Leone are mainly in the speed range of 4 - 12 knots. Observed wind speeds of greater than 20 knots are rare and gale force winds extremely rare. Strong to gale force winds do occur in association with rain storms but are short lived.

The rain period is generally from May to November, July and August having the highest rainfall. The season is well defined and little or no rain falls in the dry months from December to May.

The North East trade wind, which blows almost continuously from the North as far south as Senegal, comes further south and reaches Sierra Leone waters by the end of the rain period in December. This north wind then prevails until the return of the rain period, when in the north east, this wind is blowing offshore and frequently brings dust from the interior, severely reducing visibility.

During the rain months, winds offshore are generally from the South West or West, and light.

Throughout the year, the coastal inshore waters where artisanal fishermen operate are subject to land and sea breezes which usually overcome the prevailing offshore wind. The land and sea breeze conditions are accentuated in the case of a peninsular as in the Shenge area. The land breeze begins in the early hours around 3 - 4 am and blows until 9 - 10 am when the calm period sets in. Once the land has heated up, the sea breeze begins, usually by midday. The sea breeze is generally stronger than the land breeze and builds up to 7 - 9 knots wind speed at its peak around 18.00 hours, decreasing to calm by 21.00 hours. This pattern may be disturbed by cloud cover which prevents the heating of the land and alters the timing. In general, the more heat generated, the stronger the sea breeze.

The sea conditions around the Shenge peninsular and in Yawri Bay are generally slight. Tidal range is 2.2 metres at springs, resulting in currents off the headland up to 2.5 knots.

Offshore currents from the north starts in November and continues at varying strengths from half to one and a half knots until June. From June to September/October, the current direction is variable and often inshore. During the dry months a swell from the north builds up in Yawri Bay but it is not sufficient to inhibit fishing operations.

5. MATERIALS AVAILABLE FOR SAILING RIG CONSTRUCTION

5.1. Masts

There are several species of tree in the coastal region suitable for mast making. The best is known locally as the 'monkey apple'. This tree is often available in straight lengths up to 7 metres and dries to an acceptably low weight. Other species of sufficient length and straightness are available, but care is needed in selection as many have frequent branches weakening the spar.

Near to the regional centre of Moyamba, approximately 80 kms inland, plantations have been established by the Government Forestry Department. Suitable poles for masts are sold and may be transported on the fish trading lorries.

5.2. Spars

There are many stands of bamboo in the region. With careful selection, lengths up to 9 metres of diameter suitable for both light and heavy spars can be cut. The bush areas of the coast have many saplings suitable for spars and outrigger poles. These may be purchased from farmers who will transport them to the road.

5.3. Sails

Freetown traders import both cotton and nylon cloths suitable for sailmaking. There is no indigenous cotton industry though cotton staple is grown and exported in small quantities.

Most traditional type sails are presently made from 4 oz. nylon which is too light for stable sail shapes. The consultant used 6 oz nylon for small craft sails and 8 oz cotton for larger sails. Both these are readily available from a number of Freetown traders. The same material is also available in Moyamba but prices and supplies are variable.

Nylon twine suitable for machine sewing of sails is imported but is not often available. However, a small quantity will make many sails and this item can be specially imported at low cost. Nylon twine for hand sewing of roping and cringles is generally available as it is also used for net repair.

Treadle powered sewing machines are used in all villages for making clothes. Tailors are generally skilled and quickly learn sailmaking techniques. Machine spare parts are not available in the villages but are usually obtainable in Freetown.

5.4. Running Rigging

Prolypropylene rope of 3, 4, 5, 6, 8 and 12 mm is generally available from Freetown traders. The Project also maintains a stock of all sizes for resale to fishermen.

Hardwood pit sawn boards are available for the making of dead eyes for turning blocks. Shenge secondary school workshop and tools were used by the consultant, but village carpenters have all the tools and skills required.

5.5. Standing Rigging

Wire rope is not generally available and if imported is too expensive for fishermen. Sailing rigs designed for small craft do not require standing rigging. For larger craft, experiments were made using 6 mm mild steel reinforcing bar. This proved satisfactory even with the narrow staying angle provided by the small beam of the canoes when used with spreaders. The reinforcing bar was turned around dead eyes and twisted to prevent slipping. The stay was then strained by lacing to a lower dead eye lashed to the vessel's frames. This mild steel material will rust, but is expected to have a useful life of at least two years and is readily and cheaply available when replacement is required.

6. ACTIVITIES. SHENGE.

6.1. Selection of Boats for Sail Trials

Most of the Standard canoes and all Kru canoes use sail and paddles for propulsion. Only a few Standard 3 - 5 boats have outboard engines. There are between 350 and 400 of these craft in the project area and their numbers have been increasing in recent years.

The smaller canoes use a triangular sail set on bamboos with the apex in the bottom of the boat. Larger standard canoes use a square sail made of nylon material set as a sprit sail. Both sail types are hand sewn and roped at the corners and edges. The roping usually gathers the material in the wrong place, causing bags and loss of aerodynamic efficiency.

Neither sail type is used to sail to windward as they cannot be set close to the wind and the hulls make considerable leeway. Courses at right angles to the wind (reaching) are the best which can be managed in normal sailing conditions. In light airs with no sea, progress to windward is possible but in these conditions it is faster to paddle. All canoes are unstable and require considerable crew agility to balance during both sailing and fishing gear handling.

The consultant proposed an improved sail of the Delta type and the fitting of outriggers and lee boards to the craft. The balancing effect of the outrigger was expected to allow a larger sail area to be set for good performance in the predominantly light winds and to improve stability for fishing gear handling, allowing the use of larger nets.

The proposal was discussed with community leaders by the Project manager and a 7 metre canoe was offered by the village of Katta for the experiment.

The Ghana boats of the Project area land approximately 70% of the fish. During discussions with the village headman it was requested that sails be designed for Ghana boats as they wished to participate in the programme.

The proposal was discussed and fishermen pointed out that the fishery in the Shenge Region is not competitive in the same way as on the Freetown peninsular or the northern part of the country. (Trials with sail rigs for Ghana boats had been carried out in a previous FAO consultancy in 1982 at Tombo). Many boats find themselves far out into Yawri Bay by the end of the day's fishing. At this time, the sea breeze is fair for a reach to return to Plantain island or Katta. The headman of Katta offered his 15.5. metre Ghana boat for the trials.

6.2. Sailmaking

The consultant had purchased nylon and cotton cloth for sailmaking in Freetown and brought a quantity of machine twine, hand sewing needles and palms, splicing fids, knives, and sewing machine spare parts. Shenge village has one respected tailor whose machine is in reasonable condition. The Project manager proposed that he should be taught the skills of sailmaking by the consultant in the construction of sails for the trials. Future business of making improved sails for the fishermen would be directed to the tailor.

The consultant designed a Delta type of sail for the 7.0 metre Standard 3 - 5 boat. This was chosen as it resembled the triangular sail in use on some of the small boats and is well proven for light wind performance. Sail area was calculated on the basis of the craft being fitted with an outrigger for improved stability. Square sails set in the sprit configuration on 7 - 8 metre LOA standard boats averaged 17 sq.m. in area. The improved performance of the Delta sail requires less area and the sail dimensions were calculated for 14.2 sq.m.

Sail shapes for the Ghana plank boat were calculated for a two mast rig, a loose footed gaff sail on the forward main mast and a smaller gunter sail on the after mizzen mast. Sail areas are 19 sq.m. for the mizzen sail and 24 sq.m. for the mainsail, total of 43 sq.m.

The Delta sail is made from 6 oz. nylon material and the gunter and gaff sails from 8 oz. cotton.

Sail shapes were marked out on the ground in front of the tailor's house and the consultant demonstrated the laying out and marking of cloths, false seaming, stitching to scribe marks, corner patch reinforcing, broad seaming and tabling. The tailor learnt these skills quickly and by the end of the consultancy period was capable of all machining tasks without supervision.

Roping of sails and working of cringlees was carried out by the consultant. Project staff were trained in the techniques.

6.3. Rig Construction

Poles and spars for the rigs were cut from the bush by fishermen and project staff. Bamboos were trimmed and bush poles barked and smoothed. Fishermen had experience of the materials required from making their own rigs and located the required lengths and diameters.

Hardwood dead eyes were made up by the consultant and Project staff on a production line set up at the workshop of the Shenge secondary school. Hand tools from the school store were used.

Standing rigging is required for the Ghana boat rig. The stays were made up from 6 mm mild steel reinforcing bar. Eyes were formed at the upper end around cleats let into the mast head and at the lower end around dead eyes. Corresponding dead eyes are lashed to the upper stringer and lanyards between the two used to strain the rods taut. To provide an improved staying angle to increase support for the mast, a spreader was fitted on the main mast. Mizzen shrouds provided sufficient lateral support. Forward support was provided by leading the vang from the main gaff through a dead eye on the mizzen mast head.

Splicing of polypropylene ropes to dead eyes to form purchases for halyards and sheets was demonstrated to Project staff. Halyard falls and dead eyes are made fast through holes bored in thwarts, knees and stringers.

Steering of the Ghana boat is by oar, between 2.6 and 3 metres in length. The use of a rudder was not tried in view of the difficulties of installation and the resistance of the fishermen to the idea.

The Standard 3 - 5 man canoe does not require standing rigging. Halyard and sheet purchases were made up in the same way as for the Ghana boat.

6.4. Sailing Rig Installation

7.0 Metre LOA 3 - 5 man Canoe with Outrigger.

The canoe provided for the trials is typical of those found in the region, approximately two years old, with several split planks and rot in many of the grown frames, and unpainted.

To stiffen up the hull and provide strong points for mounting the outrigger cross members, a new stringer was fitted from stem to stern 20 cms below gunwhale height. The stringer is nail fastened into the frames.

Outrigger cross members made from bush poles are fastened to the stringers with square lashings of 3 mm polypropylene line. The cross members rest on the gunwhales and are lashed on both sides of the hull. A plastic water pipe of 11.4 cms diameter is used for the outrigger float. The pipes are imported and readily available at reasonable cost.

Two verticals were lashed to the pipe with holes bored in their upper ends to fit the rebate on the end of the cross members. These verticals are stiffened by knees nailed between them and the cross members. The pipe float is set up with a bows-up attitude so as to assist planing and lessen the tendency to 'bury' when the outrigger is to leeward. The height of the verticals is adjusted so that the outrigger cross members are horizontal when the craft is floating on its load waterline, i.e. complete with net and crew.

The pipe float is fitted with end bungs of timber secured by screws and pitched to assist with preventing leakage. The forward bung is shaped to assist with lift when in the water. The after bung is fitted with a drainage hole and cork.

The outrigger cross members are stiffened with three fore and aft bamboos, one above the float on the outboard end of the outrigger, one 20 cms from the gunwhale on the same side, and the third 20 cms outboard on the opposite side to the outrigger. The latter is smoothed off and used as a shooting bar when laying and retrieving the net. All three are fastened with square lashings to both cross members.

7.0 metre LOA canoe sail rig.

A new thwart is nail fastened to the new stringers so as not to touch the hull planking. The thwart is bored out to the mast diameter and carries the side loading of the sail rig. A mast step of hard wood is nailed across three frames to spread the load and bored to accept the rebate on the mast foot.

The halyard is a single part purchase made up through a hole bored in the thwart. The sheet is a single part purchase with the lower end made fast to the new stringer near the stern.

Steering is by oar of 1.78 metres LOA. Rope eyes for the oar are positioned on each quarter and the oar used on the leeward side for best leverage.

A leeboard made by project staff of hardwood 1.2 metres deep and 40 cms wide, is fitted with a rope lanyard and made fast to the stringer when sailing, on the lee side.

15.5 Metre Ghana Plank Boat.

The vessel provided is typical of the ring net boats of Katta and Plantain Island, approximately three years old and in need of renovation with many split and rotten planks and frames. Leakage is considerable, particularly in the stern around the outboard well.

The boat has substantial thwarts at gunwhale height spaced at approximately 1.5 metre centres the length of the hull. The rig was designed so that mast positions coincided with two of the thwarts which are bored out to the mast diameter. Mast steps are of hard wood nailed across three frames and bored to the rebate on the mast foot. The boat has one stringer at gunwhale height. This is bored for the lashings of the lower dead eyes for both mast shrounds. The fore stay lower dead eye is lashed around the stem.

The Ghana plank boat is a net handling platform for the ring or seine net. The whole length of both gunwhales is required for shooting and hauling these large nets. Shooting the net is done at maximum speed around visible signs of fish, which may escape if the operation is held up. The sail rig is organised so that sails can be quickly stowed, lashed vertically against the masts, and shrouds easily cast off and lashed to mast steps when prospecting for fish under power begins. The forestay is left set up and the mast used for extra vision range when scouting for fish shoals.

Running rigging comprises peak and throat halyards for the main gaff and single part purchase sheet. Halyard falls are made up through holes bored in the mast thwart.

The mizzen sail has a single part purchase halyard and sheet. Sheets for both sails are on lanyards and may be quickly cast off for stowing the rig.

6.5. Sail Trials

7.0 metre LOA Standard 3 - 5 man canoe with 14.2 sq.m. Delta sail and outrigger.

The canoe was sailed both with and without the outrigger to demonstrate the balancing effect. Without the outrigger, the heeling effect of the sail and the leeboard required considerable crew agility to maintain stability. The heeling moment of the Delta sail is greater than that of the traditional sail, however crew balance is required for the traditional sail. The performance with the Delta sail was a definite improvement but not quantifiable as the craft was too unstable for instrumentation. However, the craft beat to windward with little leeway which is not possible with the traditional sail.

The balance effect of the outrigger transforms the canoe for fishing gear handling, crew comfort and sail carrying ability. The outrigger is mounted on the starboard side. When sailing on the port tack, crew weight is used on the shooting bar on the port side to assist the float, which is to leeward. If the sail is not released in a gust of wind and crew weight is wrongly positioned, the float goes under water and the craft comes to a stop. In these conditions, the craft does not capsize even if the sail is not released.

When sailing on the starboard tack, crew weight is less important, but skilled use of the weight can maintain the outrigger flying with consequent increase in speed. On this tack, if the sheet was not released in a gust of wind, the craft may become flooded. Overall crew weight is less critical to sailing performance than in the traditional craft.

The use of the leeboard allows good progress to windward, particularly with the absence of heeling as the board maintains the best attitude. The tack of the sail is made fast on the stem, when tacking through the wind the lashing is cast off and the sail pulled aft. It is passed aft of the mast and re-fastened on the stem as the canoe passes head to wind. The operation proved simple and easily handled by one man.

When sailing on courses from 60 deg. off the wind through to a run, the lee board is not required. The tack lashing is progressively eased until when running the yard and boom are resting against the mast at right angles to the craft. This sets a stable sail plan in following wind conditions with little tendency to yaw. Steering oar operation is satisfactory.

The canoe was sail trialled with instrumentation (for results, see Appendix 1) on fishing expeditions and demonstration sails to other Project communities.

Fishing Trip. 7.0 metre Outrigger Canoe, Delta Sail.

The canoe was sailed by the craft's usual captain and crew who had received some training, with advice from the consultant. The fleet of 16 canoes left Katta village at 16.00 hours and paddled upwind for 1.5 hours. Sprit sails were then set and the fleet reached as close to the wind as possible for a further half hour before setting the drift gill nets at 18.00 to 18.30. The outrigger canoe left the village with the fleet and beat to windward, arriving at the sail setting point at about the same time. The outrigger canoe then reached with the fleet, overhauling all boats until signs of fish were spotted and the net set beyond the fleet.

The fleet tends to fish in a bunch for safety reasons as these unstable craft can be upset by an odd wave or fouled fishing gear.

The outrigger canoe was able to set the net at a faster rate than the rest of the fleet by using the sail, controlling the speed on the sheet. Traditional craft are paddled by 2 - 3 men whilst the other crew member pays out the net.

The gill nets are left in the water for three quarters to an hour and hauled at dusk. This is done manually in the traditional canoes by the crew in a sitting position, taking care not to stack the net on the stowed sail and gear in the boat. The outrigger canoe stows the Delta sail out on the cross members leaving the canoe clear for net handling. The stability of the craft allows the crew to stand and haul with increased purchase.

Once the net is stowed, the fleet sets course on a broad reach for the village. Fires are lit on the beach for guidance. The outrigger canoe was among the first to arrive on the beach, having sailed through most of the fleet on the way, at 21.00 hours. The sea breeze had died away by 21.30.

There are 28 canoes carrying out this fishing pattern for the eight months of the dry season. As they are gilling predominantly pelagic Bonga, catches are variable. The trial trip catch was 42 kgs with a value of Le.35. Other canoes caught double the quantity and one almost nothing. Canoes miss fishing days for net repair and crew rest.

" 15.5 metre Ghana plank Boat ketch rig 43 sq.m.

The boat had an active fishing programme which restricted the time available for sail trials. The rig was installed in the village in half a day by the consultant and Project staff. The following day the consultant accompanied the crew on a fishing trip.

On leaving the village a 09.30 there was little wind. Course was set under power at maximum engine speed, giving a boat speed of 6.4 knots (25 hp. Yamaha). Prospecting for fish was carried out under power in Yawri Bay all morning with one net set made about middday. Hauling the net took about two hours and the sailing rig in its stowed position did not intrude. Fish catch was poor and mostly small demersals.

After restowing the net, prospecting continued further out in the Bay where other craft were seen to have made net sets. By 16.00 the crew had not sighted fish and were despondent. Following discussion with the captain, the shrouds were then set up and the sails set, the outboard removed from the well, and course set for the village on a reach. The sea breeze of 8 knots true gave an average speed of 5 knots (for tabulated results see Appendix 1). The boat was found to be well balanced and easily steered and tacked with steering oar. Courses of 45 degrees to apparent wind reduced speed to 3.5 knots with leeway angle of approximately 10 degrees. Running the outboard at approximately half speed cut out leeway and gave a boat speed of 6.8 knots.

The main sail is sensitive to correct trim. When reaching, the vang is set up and the sheet slacked to give a vertical leach. This increased boat speed by half a knot. During the passage back to the village, other Ghana boats came by to inspect, several captains boarding the boat to experience sailing. On arrival at the beach, a fuel saving of the order of Le.100 had been made, which improved the captain's mood. However, the day's poor performance is inevitably blamed on the new sail rig even though most other boats had caught little.

A second trip was made the following day with similar results. The captain would not agree to stop prospecting and allow data gathering of the rig's performance, so results are incomplete.

The crew later removed the mizzen mast and have retained the mainmast and sail which is being used for reaching home with slow engine power to conserve fuel, or return when the engine cannot be restarted.

7. SUITABILITY OF IMPROVED SAILING RIGS

7.0 Metre Canoe, 14.2 sq.m. sail and outrigger

The advantages of the outrigger and Delta sail combination may be listed:

a) Improved stability and operating comfort.
b) Improved sailing performance
c) Ability to sail to windward
d) All materials used locally available
e) Reduction in crew effort paddling to fishing grounds, net laying under sail, net hauling.
f) Ability to diversify fishing methods.

The disadvantages:

a) Additional cost, between Le. 300 and Le. 400 (US$ 60).
b) Additional maintenance of outrigger system and lashings.
c) Introduction of a technique untried in the region and new to fishermen.
d) Lack of statistical information of fishing craft economic performance, catching ability, etc. on which to base judgement of suitability.

Project SIL/82/015 estimates of costs and incomes by comparable boats are incomplete as the frame surveys have been operating for only a short time.

Table 2 shows a preliminary assessment.

7.0 metre Standard 3 - 5 Boat. Annual Expenditure

	Le.
Vessel depreciation, Le 5000 over 3 years	1,700
Vessel repair, 40% of purchase price	2,000
Net depreciation	5,000
Net repair	500
Wages, 3 x men, 180 days at Le.5/day	2,700
	11,900
Fish sales with average catch of 80 kg at average price of Le.1.20 per kg.,	18,000
Gross Profit	Le6,100

8. CONCLUSIONS

1. Suitable sails and sailing rigs can be manufactured in Shenge using locally available materials at a cost affordable by fishermen/boat owners.

2. Artisans of the region may be quickly trained in the skills and techniques of sails and rig making.

3. Prevailing land and sea breeze conditions are suitable for operation of inshore fishing craft.

4. The Delta rig and outrigger combination improves performance of the Standard 1 - 3 and 3 - 5 canoes, particularly to windward. The use of an outrigger also improves safety and workability allowing diversification of fishing methods.

5. Improving sailing skills may result in increased fishing effort and less requirement for mechanisation.

6. The Ghana boats can make significant fuel savings from the use of auxiliary sail. Other benefits include the ability to fish when fuel is in short supply and to return in the event of being unable to start the engine.

9. RECOMMENDATIONS

The consultancy activities should be followed up by a masterfisherman to develop the use of the sail/outrigger combination to exploit the fish resources being identified by the SIL/82/015 exploratory fishing programme.

The scope of the follow up programme to be as follows:

1. To introduce by practical demonstration new fishing techniques and fishing methods to the fishermen of the project area so as to improve the use of presently underexploited species such as shark, snapper and crustaceans.

2. To design, implement and evaluate training programmes in seamanship, safety at sea, use and care of sails and canoe maintenance.

3. To contribute to the exploratory fishing programme being conducted by SIL/82/015 as required by the project.

4. Conduct an experimental programme to evaluate relative merits of 4- and 2-stroke oubtoard engines on traditional fishing craft.

5. To train Government of Sierra Leone counterpart fisheries staff in all aspects of the project's activities.

6. To make recommendations on future development of the artisanal fishery, the tools and equipment needed to further increase production, and on the adaptation and necessity for improved canoes within the capabilities of the artisanal fishermen and boatbuilders.

An additional activity (for which a specialist consultant would be advisable) should be carried out at the early stages of the follow up project, to train artisans and boatbuilders in sailmaking and boatbuilding.

This training activity will:

1. Train district artisans and SIL/82/015 project staff in the techniques of sailmaking and sail rig construction using locally available materials as demonstrated in the consultancy.

2. Train district carpenters and boatbuilders in methods of improving present boat building techniques, construction of outrigger floats and installation of improved sailing rigs.

Appendix 1.

SAIL TRIALS

1. 7.0 metre Canoe. 14.2 sq.metres Delta Sail
Outrigger starboard sided.

29 October 1985.

Apparent Wind speed	Knots Boat Speed	Apparent Wind Angle	Tack	Remarks
4	3	50	S	
4	2.5	50	P	
3	3	90	S	
5	4.2	90	S	
2	1.5	160	P	
4	2.2	45	S	
4	2.0	45	S	
4	2.0	45	P	

6 November 1985

9	4.2	45	P	
8	5.5	50	P	
9	6.0	50	P	Without leeboard
10	6.2	100	S	
11	6.5	100	S	

Appendix 1 (2)

2. 15.5 metre Ghana Boat, 43 sq.metre sail.

2 November 1985

Engine	Apparent Wind Speed	Boat Speed	Apparent Wind Angle	Tack	Remarks
Full		6.5			25 hp. Yamaha
0	5	2.0	45 deg	P	15 deg leeway
0	4.5	1.5	45 deg	P	15 deg leeway
.25	6.0	4.8	45 deg	P	No leeway
.50	8.5	6.8	45 deg	P	No leeway
0	5.5	3.2	50 deg	P	5 deg leeway
0	10.0	4.8	60 deg	S	
0	10.0	5.0	60 deg.	S	
0	6.0	2.8	150 deg.	S	
0	5.5	2.6	160 deg.		

6 November 1985

.50	6.5	5.5	60 deg.	S	
Full		6.5			Searching for fish shooting ring net
0	4.5	2.3	90 deg.	S	
0	4.0	1.9	90 deg.	S	
.50	9.0	6.8	90 deg.	S	
.50	9.0	6.6	90 deg	S	

Note 1. All measurements taken by Stowe Instrumentation trailing log, anemometer, wind direction meter.

Note 2. All measurements taken during fishing expeditions, fish catching being first priority.

Appendix 2.

RIG COSTS

7.0 Metre Canoe, 14.2 sq.metres sail.

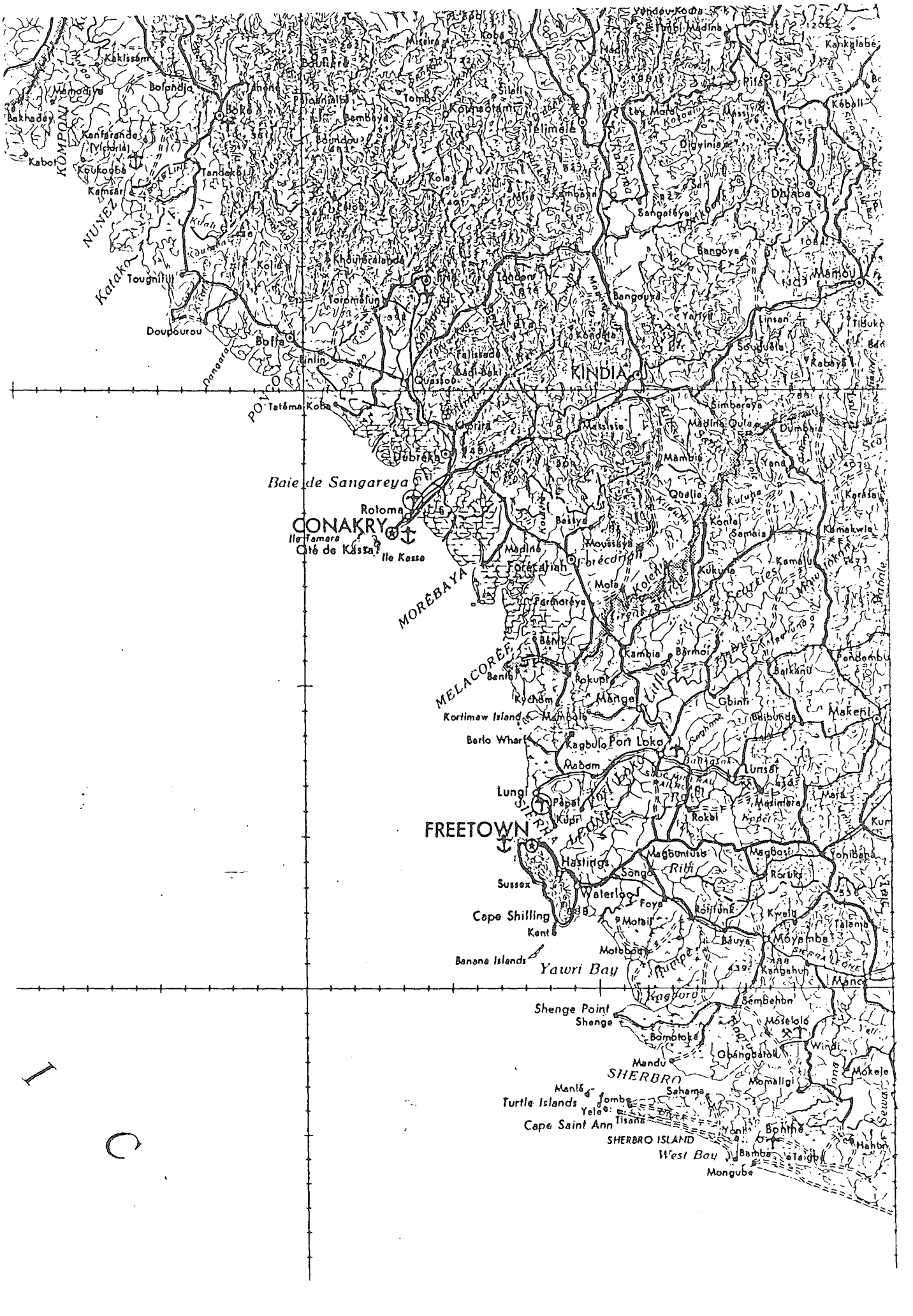
	Le.
Sail cloth 20 sq.metres.	150.0
Sewing twine	17.0
8 mm rope, 40 metres	54.0
4 mm rope, 50 metres	21.5
3 x 4 metre poles	34.9
Bamboo	10.0
Sail making labour	35.0
2 x 1.8 m. oars	30.0
1 x lee board, 4 x dead eyes, 2 x stringers	15.0
3 metres plastic pipe, Le 8/metre	24.0
	391.4 Le

Equivalent to US $ 71.

15.5 Metre Ghana Plank Boat. 43 sq.metres Sail

Sailcoth, 55 sq.metres	720.0
Sewing twine	17.0
8 mm rope, 100 metres	130.0
6 mm rope, 50 metres	44.0
4 mm rope, 50 metres	21.5
2 x 8 metre masts	30.0
3 x bamboos	15.0
6 lengths 6 mm. reinforcing bar	150.0
17 dead eyes	25.0
Sail making labour	65.0
	1217.5

Equivalent to US $ 220.


Yendou Koda
Kankalabé
Kaklissam
Boulléré
Missira
Koba
Mamodiya
Bolpndia
Pita
Bakhadaye
KOMPONI
Boké
Tombo
Sitali
Kounsotami
Télimélé
Kakrima
Kéballi
Kanfarandé
(Victoria)
Kabota
Koukouba
Kamsar
NUNEZ
Tanda
Kolé
Diguiinia
Dalaba
Bangafeya
Bangoya
Mamou
Kataka
Tougnifili
Khouibolabé
Tiéné
Lagdéré
Doupourou
Boffa
Toromafung
Bangouya
Yarré
Linsan
Tibuko
Bouroubé
Pakaté
Kondeta
Souguéta
Kabaya
Linlin
Falissado
Sadi Baki
Ouessou
KINDIA
PONGO
Tatéma Koba
Coyah
Dubréka
Simbareya
Madina Oula
Dumbaia
Massisse
Mambia
Baie de Sangareya
Rotoma
CONAKRY
Ile Tamara
Cité de Kassa
Ile Kassa
Yana
Kolle
Kulufa
Samaia
Kamakwie
Bassya
Moussaya
Madina
Forécariah
Mola
Kukuna
Kamalu
Scarcies
MORÉBAYA
Farmoreya
Bonk
Kambia
Barmoi
Fandombu
MELACOREE
Benti
Rokupr
Batkanu
Rychom
Mange
Gbinti
Kortimaw Island
Mambolo
Kagbulo
Port Loko
Makeni
Barlo Wharf
Rabom
Bullagosi
Lunsar
Lungi
Papel
Kupri
Rokel
Masimera
Mara
SIERRA LEONE
FREETOWN
Hastings
Magbontuso
Songo
Magbosi
Yonibana
Sussex
Waterloo
Rotifunk
Ribi
Foya
Cape Shilling
Kent
Motoli
Bauya
Moyamba
Taiama
Motobon
Banana Islands
Yawri Bay
Bumpe
Kangahun
Mano
Shenge Point
Shenge
Kagboro
Sembehun
Mokelo
Bombotoke
Windi
Mandu
Obangbatol
SHERBRO
Momaligi
Manlé
Turtle Islands
Sahama
Jombe
Yele
Tissana
Cape Saint Ann
SHERBRO ISLAND
Yoni
Bonthe
West Bay
Bamba
Taigbe
Mongube
Sewa
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