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APPROPRIATE SAILING RIGS FOR ARTISANAL FISHING CRAFT
IN DEVELOPING NATIONS

by

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SYNOPSIS

The plight of many subsistence and artisanal fisheries, caused by fuel costs and mechanisation problems, is described. The authors, through experience of practical sail development projects at beach level in developing nations, outline what can be achieved by the introduction of locally produced sailing rigs and discuss the choice and merits of some rig configurations.

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1. INTRODUCTION

Small-scale artisanal fisheries of the developing countries produce at least one third of the annual world food fish catch of some 55 million tons. Between 20 and 30 million artisanal fishermen, their dependents, traders and distributors, depend on small-scale fisheries for their livelihood and because of the geographical dispersion of these fishing activities fish distribution is widespread.

Traditional small-scale fishing craft vary greatly in design but not in concept. They are manufactured from locally available materials and develop within the constraints of those materials. Until recent times, propulsion has been by paddle or sail generally with high levels of competence. Many small-scale fishing craft are beach based, launched and recovered by their crews.

Since the 1950s, mechanisation has been introduced almost universally and many changes have been seen in small-scale fisheries. Mechanisation has resulted in improvements in productivity, by increasing available fishing days, opening up new fishing grounds and in the introduction of more efficient fish catching methods.

Many canoe type small boats have benefitted from outboard motors and larger traditional craft have been fitted with diesel engines. In the era of abundant cheap fuel, mechanisation resulted in increased supplies of fish for human consumption at prices affordable by rural populations.

Rapid rises in fuel prices in the 1970s have threatened the economic viability of small-scale mechanised fishing vessels which are still operated on patterns established during the cheap fuel era.

2. RISING FUEL COSTS AND THEIR EFFECT ON SMALL MECHANISED FISHING CRAFT IN DEVELOPING COUNTRIES

Two major effects on the viability of artisanal fisheries have resulted from fuel energy cost increases. The first and most obvious is the direct rise in operational costs due to increased fuel and oil costs. At the same time the general recession caused by fuel costs increases has decreased the purchasing power of consumers in developing countries. This has put pressure on primary producers such as farmers and fishermen, not permitting the prices of primary products (including

fish) to rise at a rate that will permit the increased operational costs to be passed on.

Secondly, the greatly increased foreign exchange requirement for the purchase of fuel oil and the higher prices charged for imported manufactured goods have caused such an imbalance in the external trade of many developing countries that they have difficulty in obtaining sufficient foreign exchange for the importation of even the most essential amounts of fuel oil and mechanical equipment. All of us are familiar with fuel cost increases in our own countries which affect us directly, for example gasoline cost about U.S.\$ 0.30 per gallon in Florida in 1973, while now in 1983 the cost is about U.S.\$ 1.10 per gallon. However, in many developing countries even higher price rises have occurred and for the reasons given above price increases cannot be passed on to the consumer. Therefore, fishermen have been forced to absorb the increased operating costs which over the period have reduced profitability, incentive and activity.

Some examples from FAO Sail Project experience indicate the gravity of the situation.

In Somalia, with per capita earnings of U.S.\$ 180, gasoline is only available with Government permit for every litre bought at the pumps. Diesel is more easily obtainable at equivalent U.S.\$ 2.20 per gallon (1982) but is of poor quality with many impurities. Engine spare parts for most small engines have been unobtainable for some years, except when supplied by aid organisations.

In Guinea Bissau (PCE\$ 160), fuel is seldom available. Periods of two or three months without supplies for the fishermen are not uncommon. The price of gasoline is equivalent to U.S.\$ 3.47 per gallon and diesel U.S.\$ 1.69 per gallon.

In Sierra Leone fuel is generally in short supply. In recent months, the supply situation has deteriorated further and artisanal fishing activity has been severely reduced. Petrol prices of equivalent U.S.\$ 2.7 per gallon already represent 70 percent of operating costs. This should be compared with the 1978 per capita earning of U.S.\$ 182.

In Senegal (PCE\$ 223) the small-scale beach fishery is very highly developed and supplies large quantities of fish to the rural population via a well organised artisanal distribution system. There are approximately 3 000 canoes operating on the coast, using modern fishing methods to meet ever increasing demands. Almost all canoes are outboard motor powered. The Government has subsidised the small-scale fishery by allowing fishermen to purchase fuel and outboard motors without the 60 percent tax paid by all other users. Even with this advantage, fuel costs of equivalent U.S.\$ 1.20 per gallon represent 40 percent of operating costs. Without the subsidy, the operation of the motorised canoe fishery would not be viable.

The subsistence fishery in Madagascar continues to supply small quantities of fish to coastal villages using traditional sail powered outrigger canoes. Attempts to develop an artisanal fishery have been unsuccessful as operating costs of engines make the operation uneconomic.

In Indonesia, fuel prices to small-scale fishermen have increased by 300 percent from January 1982 to January 1983. Market forces have held the price of fish to within 30 percent of their 1979 level. There are many restrictions on industrial fishing operations to conserve fish stocks and encourage small-scale fisheries, but with present motorisation in certain parts of Indonesia the small-scale fishery is uneconomic.

At the present rate of decline, many artisanal and small-scale fisheries, which are already economically marginal, will severely reduce catching effort. Inevitably, the areas affected first are those with the most pressing need for improved diet - these areas are in danger of losing a large proportion of its fish catch as a valuable source of protein.

3. SOME SOLUTIONS TO THE PROBLEM

The task of reducing fuel costs in small-scale fisheries must be tackled on many fronts. This paper is primarily concerned with the use of sail power as a means of reducing fuel consumption and thus operating costs, but other avenues must also be pursued. Reference (1) lists five options which could be used singly or in combination:

1. Develop improved energy efficient engines and/or propelling devices.
2. Concentrate on reduction of hull resistance in the design of new fishing vessels.
3. Change fishing emphasis from high energy consuming fishing methods to those requiring lower energy inputs, e.g. a switch from stern-trawling to mechanized longline systems for high quality bottom fish stocks.
4. Reduce installed hp and operating speeds.
5. Use alternative energy sources, e.g. wind power.

3.1 Improved engines and propelling devices

Outboard motors used in small-scale fisheries are principally designed for the leisure market. These are lightly constructed, high revving, two cycle engines with intricate electrical systems, requiring a high level of maintenance and spare part replacement. They are not designed for commercial operation and in the prevailing conditions of artisanal fisheries in developing countries, have a useful life of one to two years. Fuel consumptions of the order of 0.7 lbs/hp hour and additional cost of 2 cycle oil, were not serious constraints during the time of cheap energy. Spare parts were readily available before restrictions on foreign exchange.

The convenience of outboard motors is such that they will never be completely replaced. The technology exists, however, to produce engines suitable for small-scale fishing operations, with long life, good specific fuel consumption, and the durability necessary to survive in working conditions.

An alternative to the outboard is the small air cooled diesel engine which is more fuel efficient and durable than present outboards. Problems such as higher initial expenditure, increased weight, protection of an engine against swamping in beach landing craft and the difficulty of fitting propeller and sterngear for these conditions can be overcome. One FAO project in the Bay of Bengal is gaining acceptance for an inexpensive low hp engine of this type totally enclosed in a pivoting engine box with incorporated sterngear, propeller and rudder which can realise fuel economies of the order of 50 percent over the equivalent outboard powered craft.

3.2 Rationalisation of Power Requirements According to Fishing Method

With cheap and abundant fuel there was little incentive to carry out careful matching of engines, sterngear and propeller, while the tendency to increase horsepower progressively to the point where up to 30-40 percent increases in fuel consumption resulted in speed increases measured in fractions of a knot.

Considerable attention is being paid in a number of FAO fisheries projects in developing countries to this problem and it would appear that the most immediate results in fuel saving can be expected from a combination of choices 4 and 5 in the options listed above.

Probably the most significant fuel saving in small fishing craft can be achieved by a reduction in operating speed, i.e. a reduction in utilized Shp/ton of displacement, (always provided that an appropriate propeller is fitted for the reduced operating hp and rpm). Recent fuel consumption trials of an 8.7 m (28 ft 6 in) inshore fishing craft with a 30 Bhp engine indicated that a one knot reduction in speed from 7 to 6 knots for this craft resulted in a reduction from 6 hp utilised ton of displacement of 2.6 and a reduction in fuel consumption of about 30 percent. Actual fuel consumption in litres/hour dropping from 6.5 to 2.4. While this sort of saving can be expected in small craft operating near their maximum hull speed, such savings in fuel costs do not take account of the cost of increased voyage time, possible reduction in fish prices for later arrival in port, nor the human reaction of a fisherman not wishing to see his contemporaries pass him at a knot better operating speed.

3.3 The use of Sail

One solution to this latter problem is the use of combined sail and engine power to produce equivalent speeds at substantial fuel saving.

For this particular vessel it was possible to demonstrate that the use of 24 m² of sail in a 15 knot true wind using 65 percent rpm (approximately 60 percent of maximum continuous Bhp) gave an operating speed of 7 knots at an apparent wind angle of 90° and 6.5 knots at an angle of 50°, see Fig. 1. From this figure it can be seen that at an average

operating speed of 6.5 knots fuel consumption in litres/hour is 3.8 l/h under engine alone, 2.4 l/h using reduced engine power plus sail at a course angle of 50° to the apparent wind (close hauled) and 1.25 l/h at an angle of 90° to the apparent wind (reaching).

Until the turn of the century, all ocean transport was sail powered so it is natural for the reintroduction of sail as a means of propulsion to be considered to reduce fuel consumption. At the end of the era of sail, vessels, techniques, and specialisation were very highly developed, even though industrial technology was relatively primitive. In the industrialised countries since the coming of steam until very recently, sail development has been confined to recreational craft. Most of the traditional skills for handling transport ships and fishing vessels under sail have been lost.

In the developing world too, sailing as a means of propulsion for fishing craft has declined in recent years and is under-utilised in many areas despite favourable winds. In some areas such as the northeast Indian Ocean, the China Sea and Malaysia, sea-faring populations have developed sailing methods and use sail for much of the time. However, large parts of Africa, Indonesia, and Central and South America, have not developed sails for their craft through lack of suitable materials, information and motivation.

Wind patterns between the tropics are generally stable and predictable with large areas benefitting from regular trade winds. In areas where sailing has been developed, suitable combinations of hull and rig were evolved. However, their development is considerably less advanced than the sophistication achieved by the North European and American sailing fishing fleets in the early 20th century.

Some reasons for the lack of continued development in developing nations are not hard to find. Many of the hulls are not strong enough to take the strains imposed by a tall sailing rig. Materials suitable for making efficient sails have only recently become available with the increasing use of machines to weave local cottons tightly enough to be of adequate density and strength. Many countries do not have suitable trees for long, straight spars, so that sailing rigs with short masts and spars made up of several pieces lashed to form a long length have evolved.

Specialists working in the field of sail development have the advantage of an overview of rigs and techniques on a world wide basis plus experience of modern materials and technology. This enables a new approach to the design of sailing equipment for a traditional fishery within the economic and geographical constraints of the region. Ideally, this means using locally available materials in existing craft, even though some of the materials may not have been used before for sailing (e.g. galvanised wire rope). The economy of the fishery may justify importing some items such as fastenings, or nylon thread, which, although of minor importance in total cost can make surprising improvements in the efficiency of the vessel and rig.

The aim must be to develop an acceptable appropriate sailing system which causes worthwhile fuel savings and which is sufficiently convenient and inexpensive for the fisherman to adopt spontaneously.

Many artisanal fishing craft will sail without serious alterations. Almost any hull will run before the wind or broad reach. Most hulls will beam reach without appreciable leeway. To sail to windward requires a hull form with reasonably fine underwater lines and adequate lateral plane. In some small craft, this can be achieved by the addition of leeboards or centre boards.

A study of the fishery context in which a craft is operating, its hull form, and materials locally available for rig manufacture, will enable an appropriate sailing rig to be designed.

In some cases, it will be possible to design an sailing rig as primary propulsion. More often, the rig will be auxiliary, particularly when passages to windward are required. When motor sailing to windward, the lift coefficient of the hull and appendages is not critical as the engine can provide much of the necessary windward component.

In all cases, the use of engines will be necessary to maintain production levels. Project experience has shown that fishing under sail alone rarely allows the same level of effort as achieved in the time of cheap fuel. As can be seen from Fig. 1, the most significant contribution of appropriate, locally produced sailing rigs is in the context of motor sailing, where reductions in engine hours up to

50 percent have been recorded whilst maintaining previous levels of fishing achievement.

4. SAILING RIGS FOR SMALL FISHING CRAFT

4.1 Requirements of a Sailing Rig

Appropriate rigs should:

- Be constructed from materials which are locally available or can reasonably be obtained.
- Be convenient and easy to handle, and not obstruct fishing operations.
- Be easily and effectively reefed so that fishing operations can be carried out in varying weather conditions.
- Be capable of working close to the wind, as when motor sailing in light airs, the apparent wind direction will be within 45° of ahead up to 50 percent of the time.
- The propulsive efficiency of the rig should be demonstrably high enough to be attractive to fishermen, whilst ensuring the maximum possible safety for the vessel.
- For surf and open beach landing, the rig must be suitable for stepping and unshipping at sea.

4.2 Project Experience

The Food and Agriculture Organization of the United Nations has organised a number of Sail Projects in African countries. Some of these projects carried out by the Fisheries Technology Service of FAO in collaboration with MacAlister Elliott and Partners have been and are demonstrating the manufacture and installation of appropriate sailing rigs from locally available materials. This experience has been added to by other projects in which MacAlister Elliott and Partners have installed sailing rigs and introduced improved boatbuilding methods.

Tailors and local artisans have been trained in the techniques of making improved sails, and the use of synthetic fibre ropes and wire for running and standing rigging.

The completed sailing rigs have been demonstrated to fishermen in authentic fishing conditions; alterations in fishing methods, if required, have been identified and introduced.

The aim of these projects is to assist small-scale fishermen to develop sailing rigs from their own resources, which are suitable for their fishing methods and will contribute to the propulsion of their craft.

Many small-scale fishing communities have developed their fishery beyond recognition of the fishing practices of past generations. The mobility of motorisation has given a degree of independence from the previous restrictions of currents and wind. In many cases, a generation has grown up without the knowledge of seamanship required to operate fishing craft under sail and the skills have been lost.

The urge for speed and increasing amounts of horsepower is a very natural human reaction and it is often difficult to promote sail as it is considered retrogressive.

Project experience, however, has shown that in countries where fuel has become unavailable for long periods and effort has been severely curtailed, fishermen are frequently willing to learn and to apply the seamanship required to sail their craft.

On the other hand, in countries where fishing with engine power is still possible, no matter how rapid the decline in profitability in recent years, fishermen resist efforts to introduce primary or auxiliary sailing systems.

The efficiency and convenience of the rig and motor/sail balance is therefore critical for acceptance.

To assist with acceptance, programmes of training fishermen in the use of sailing rigs are proposed. Early experience of this work has been encouraging - fishermen making continuous use of sailing rigs in Cacheu in northern Guinea Bissau have convinced their colleagues of the benefits by example. Initial education was necessary to demonstrate the techniques of utilising the sailing rigs to best advantage.

5. DESCRIPTIONS OF RIGS USED IN DEVELOPMENT PROJECTS

5.1 Gaff Rig

The gaff rig was much used by fishing craft on both sides of the Atlantic until the late 1920s. The gaff schooner developed on the American eastern seaboard. The schooner configuration was popular for its windward ability in bringing to market, against the prevailing westerlies, fish caught on the Grand Banks. In European waters, the ketch and cutter rigs were more common, markets being generally to leeward of fishing grounds.

The gaff rig was introduced in an FAO project to replace the lateen rig on the Mashua type fishing craft in Southern Somalia. Many Mashua's were motorised and their sailing rigs had fallen into disuse. Fishing methods are predominantly gillnetting and handlining. The traditional lateen sail's primary disadvantages are the lack of reefing ability and the large crew required to handle the yard when setting or lowering sail, and manoeuvring.

The gaff cutter rig designed has a loose footed mainsail, jib set on the end of a bowsprit and staysail set on the forestay. There is provision for a light weather topsail. The overall sail area is similar to the original lateen and is manageable by one man. Reefing is easily accomplished, keeping a reasonably efficient sail shape for windward sailing when deep reefed, Figs. 2 and 4.

The gaff mainsail is not as efficient to windward as sails with a relatively longer luff (leading edge) but for reaching and running, the rig spreads a large effective sail area.

The gaff cutter rig was also introduced to the 5.8 m (19 ft) fishing craft on Lake Malawi. These craft are used by artisanal fishermen for gill and circle netting. The rig is used as primary propulsion, with outboard motors for use in windless weather, Fig. 3.

5.2 Sprit Rig

The sprit was commonly used by both small fishing craft and cargo vessels up to 20 m LOA in Northern European waters. The sail has a similar configuration to the gaff sail but is spread by a standing spar secured at the base of the mast, Fig. 5. The sail is normally gathered to the mast for stowing, Fig. 6.

The sprit rig was introduced for use on the 8 m GRP motor fishing craft in Somalia, Figs. 7 and 9. These boats are mainly used for gillnetting and longlining. They are fitted with deck houses above the engine space which restricts space on deck. Whilst setting and hauling fishing gear, the rig is unobstrusive.

The rig is easily handled by one man with proper running gear, and sets a large sail area when reaching or running. The sprit is necessarily a long spar and is required to be as light as possible.

The set of the sail, particularly to windward, is dependent on the stiffness of the sprit. Suitable long, straight and stiff spar material is not available in many countries.

The traditional canoe fishery in Senegal used a type of sprit rig for inshore fishing and river transport. The rig fell into disuse with the introduction of outboard engines. However, the smallest of the beach canoes still use the sprit rig. A study of their economic situation relative to the larger motorised canoes shows a profitable operation, whereas the profitability of the motorised canoes has declined. The sprit sail as set in Senegal could be considerably improved by the use of man-made fibre twine in sail making. Sails presently in use are of poor aerodynamic shape with over-stretched leach (rear edge) panels so that beating to windward is difficult or impossible. With elementary skills of sailmaking, these problems could be solved and the efficiency of the sails greatly improved.

5.3 Lug Sails

5.3.1 Chinese type, fully battened lug sail

The junk sail is still in widespread use in Southeast Asia, where it has been the primary propulsion method for all types of craft for more than a thousand years. In recent times, the junk type of fully battened lug sail has been used in other areas and with modern materials. These rigs have demonstrated the advantages of multi-part sheets spreading rig stress and quick, efficient reefing.

The junk rig forms the sail shape and holds it rigidly with the full length battens. Thus, inferior sail material may be utilised.

The junk rig was introduced in Somalia for the 6.4 m GRP coastal fishing craft, Figs. 8 and 10. These craft have small inboard diesel engines and are used for handlining and gillnetting. When reaching or running the rig gives similar speeds under sail to those achieved under power and performs reasonably to windward using a lee board. The flat shape of the fully battened sail is particularly efficient for motor sailing. The Indian Ocean coast of Somalia experiences varied wind strengths in different seasons, ranging from light airs to near gale force at the height of the Southeast Monsoon. The junk rig allows the setting of the required amount of sail for the daily conditions and swift effective reefing.

The junk rig has also been introduced in a Sail Development Project in Guinea Bissau for the larger (12-15 m) fishing canoes. The canoe hull is fine lined and easily driven, with a pronounced rocker to the hull shape which provides some stability when heeled. The junk sail stows in its lazy jacks during fishing operations; nets are handled aft of the beam or forward of the mast with the fish hold being positioned under the stowed sail. The rig is not suitable for canoes operating from a surf beach as the running rigging is too complex for rapid unshipping at sea which is necessary for passing through the surf.

5.3.2 Dipping lug

The lug sail, in its various forms, was the most widely used sailing rig amongst the small-scale fishermen in European waters before mechanisation. Dipping and standing lug sails are variations of the same principle of a yard headed, quadrilateral sail.

The dipping lug is set on an unstayed mast, the halyard being set up on the windward gunwhale so that with the tack of the sail secured at the stem head, the rig is well supported. The dipping lug is an efficient sail shape for all points of sailing but has the disadvantage of having to be lowered and re-hoisted on the other side when tacking, hence its name. The sail is set without a boom and with simple running rigging, reefing is effective and simple.

The dipping lug was introduced on Lake Malawi for the 4.5 m (15 ft) outboard powered fishing craft. In the largely stable wind conditions of the lake, the sailing performance of the rig is satisfactory for primary propulsion.

5.3.3 Standing lug

The standing lug sail is tacked at the mast so that the rig is self-tending when going about. The sail is normally set with a boom, and the mast set up with standing rigging.

In small craft such as the 7 m GRP canoe in Somalia, Fig. 11., the standing lug rig is set on an unstayed mast and used without a jib. The canoe was designed to carry an inboard diesel engine and has sufficient lateral plane for beating to windward without excessive lee-way. Fishing methods carried out from the canoe are handlining and diving for crustacea. The boom and yard do not intrude when stowed in the boat.

For the heavier displacement craft of 7.6 m in Northern Lake Malawi, Fig. 12, the standing lug is used on a stayed mast and a jib is set when beating to windward. Points reefing is effective and reasonably simple.

The standing lug has also been introduced for the beach canoes in Guinea Bissau and Sierra Leone, Figs. 13 and 14, where raw materials for sailing rig construction are scarce. However, trees can be found of adequate strength for the relatively short masts of this rig and bamboc is often available for spars.

5.4 Gunter Rig

This is similar in configuration to the Bermuda or Marconi rig, which is seldom considered appropriate in developing nations in view of the sophisticated mast, fittings and sail cutting required.

The gunter rig uses a yard in the same way as the gaff and lug rigs but the yard is set vertically above a relatively short mast. This rig is suitable for light displacement craft and is efficient for close hauled sailing.

The gunter rig has been introduced in the Bijagos Islands in Guinea Bissau fishing canoes. Results have been encouraging with good performance though the rig has proved closer-winded than the hull is capable of due to leeway. However, motor sailing allows good progress to windward with minimal fuel use.

Another use of a gunter rig for a beach landing craft in India is shown in Fig. 15.

5.5 Lateen Rig

The lateen rig (name derived in English from the rig used by Latin seafarers) in the configuration widely used in African and Asian countries, originated in the Arab world. The lateen is the first development from the square sail, and is still used in square sail fashion when running before the wind. In many small-scale fishing communities in East Africa and the Arabian Gulf nations, no other type of sail has been developed.

The lateen sail is set on a long yard, usually made up of a number of shorter pieces lashed together. The mast is relatively short, with removeable rigging to allow for changing the yard from one side to the other. In the larger sizes, manoeuvring under sail is complicated and requires large crews; reefing is difficult to accomplish and results in an efficient sail shape, particularly for windward work. The lateen sail shape when fully set on stiff spars is efficient on all points of sailing.

A lateen rig was introduced to the 6.5 m GRP motor fishing vessels in Somalia, Fig. 16. Another vessel of the same class was fitted with a sprit rig of the same area and comparative trials conducted. The speeds under sail of the two rigs is comparable for reaching and running. The lateen rig is superior for working to windward but has the disadvantage of interfering with the fishing methods with its complex running rigging, and requiring more crew to handle it.

The Jehazi of the Kenya coast, Fig. 17, have used the same lateen rig for generations. By improving the material used in sail making, stiffening the spar, and organising running rigging with turning blocks, the problems of handling the rig can be reduced and performance improved. With improvements in hull construction to absorb the point loads imposed by the rig and prevent leakage, better windward performance became possible.

6. CONCLUSIONS

Many subsistence and artisanal fisheries would benefit from the introduction of appropriate sailing rigs, either for primary or auxiliary

propulsion. However, as has been pointed out, in some situations the introduction of sailing rigs would not be justified and fuel saving efforts should centre on improving the efficiency of mechanical power installed and in its intelligent use by operators.

The introduction of sailing rigs to a fishery requires careful study and design work, followed by technical assistance to train artisans in the skills of sailing rig construction; boatbuilders in the techniques of installing sailing rigs and the necessary construction improvements; and fishermen to use the rigs to best advantage.

Experience to date has shown that these principles can reactivate fishing effort in economically deprived fishing communities.

Efforts must continue to devise appropriate and acceptable sailing rigs for developing countries and train fishermen in their use.

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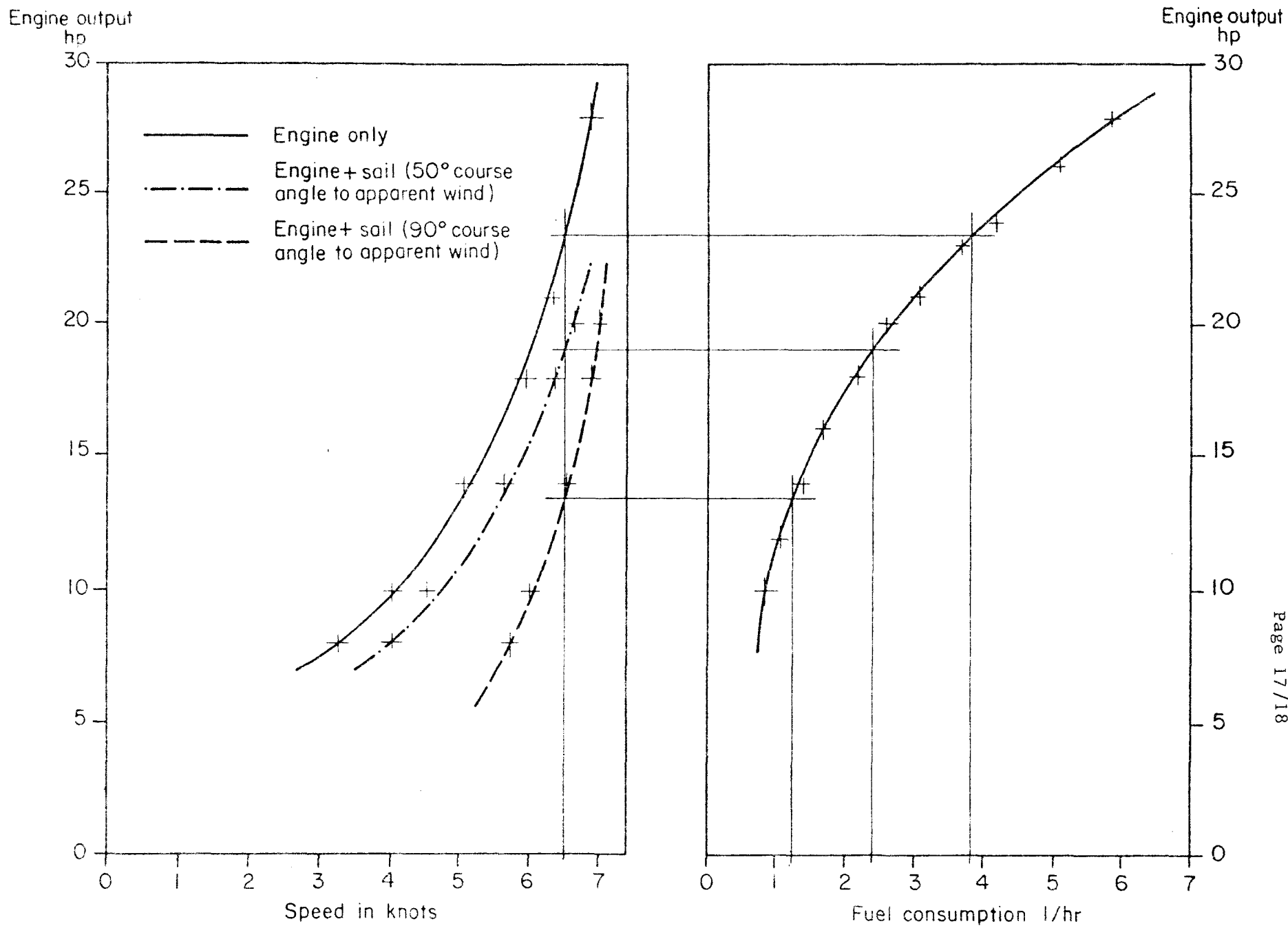


Fig. 1. Estimation of fuel consumption using various combinations of engine and sail power for an 8.5 m (28 ft) fishing boat in Somalia

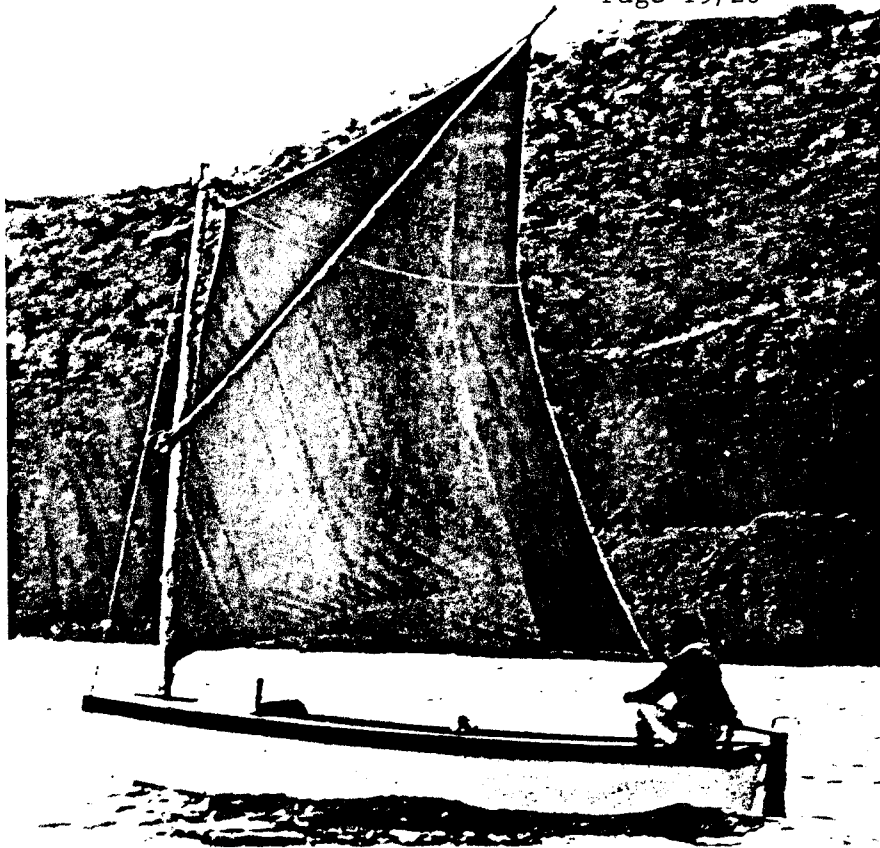


Fig. 5. Simple sprit rig on a 4.5 m (15 ft) fishing boat on Lake Malawi

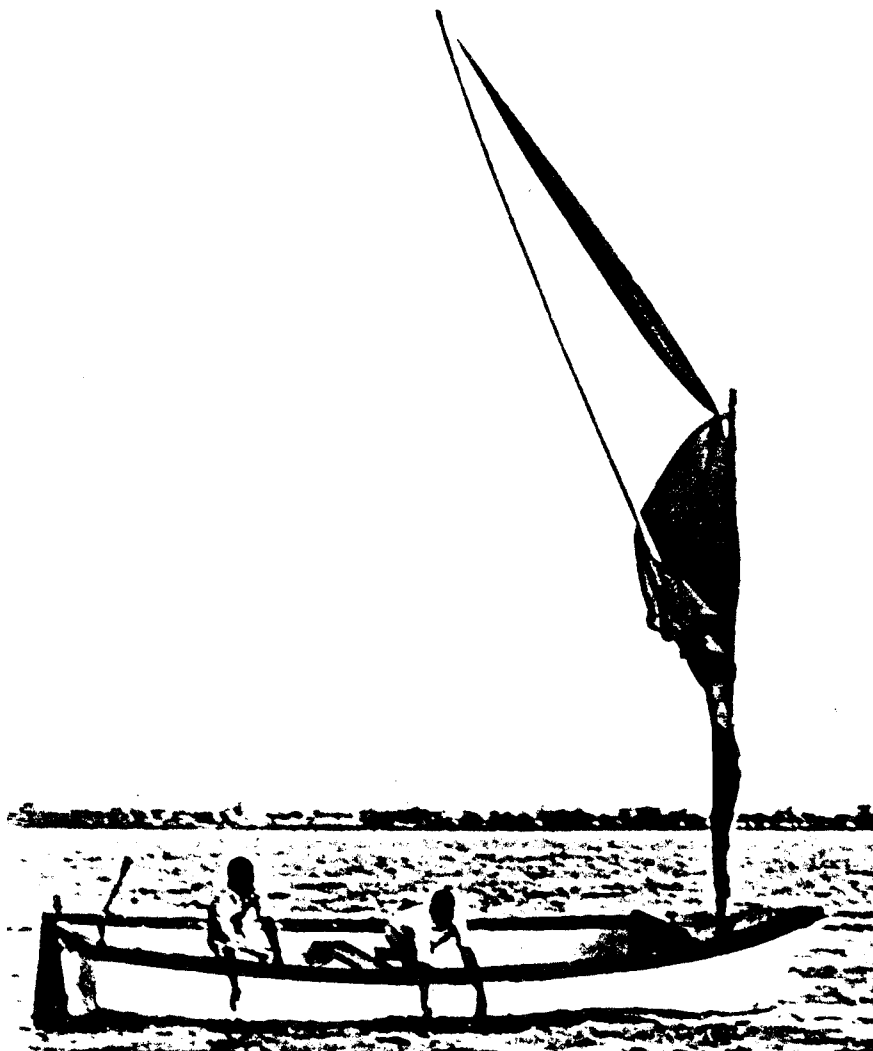


Fig. 6. Sprit sail brailed to mast leaving clear working area for fishing operations

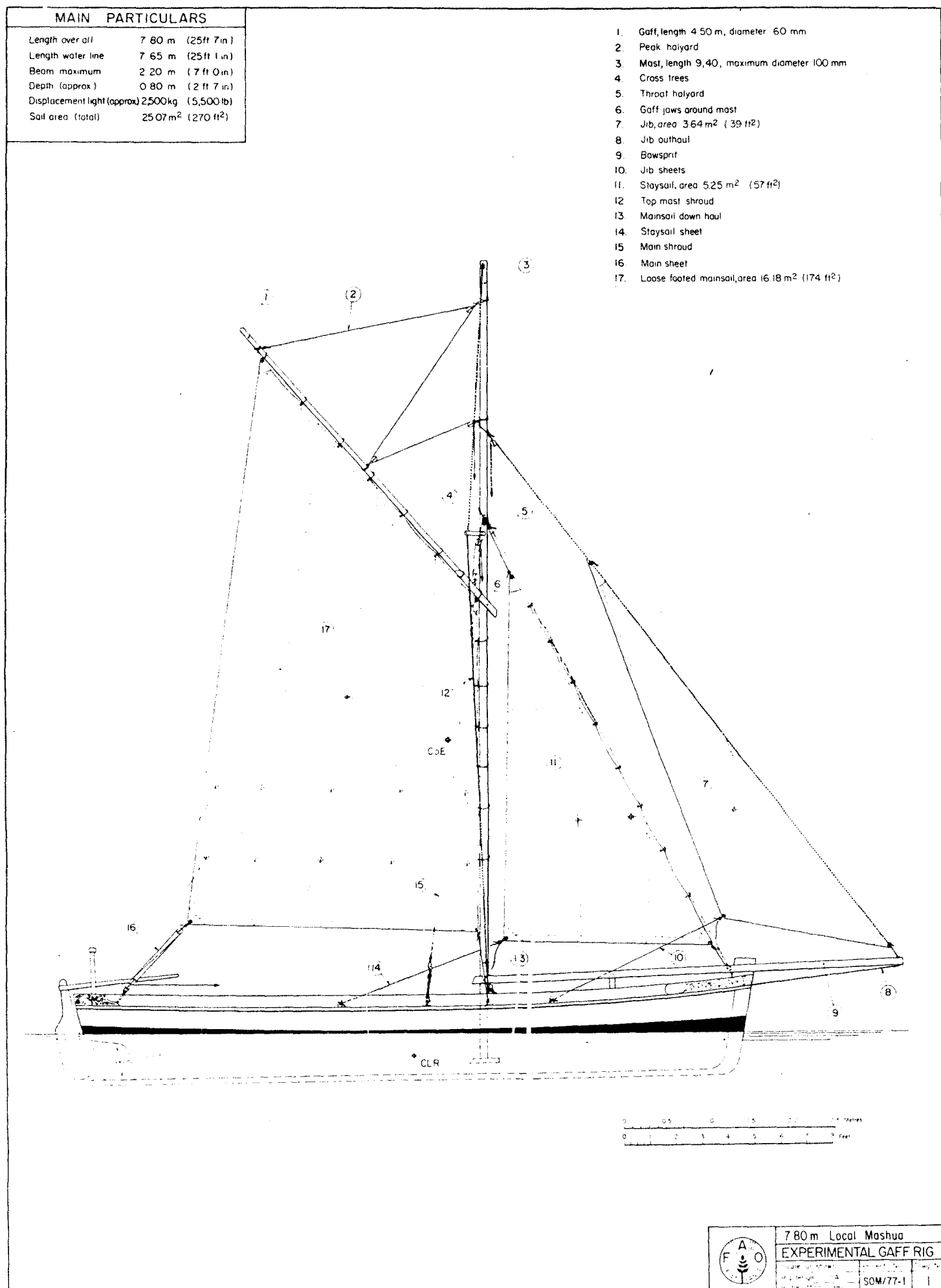


Fig. 4. Arrangement and Sail Plan of Fig. 2



Fig. 2. Gaff rig as a replacement for lateen rig on a traditional Mashua

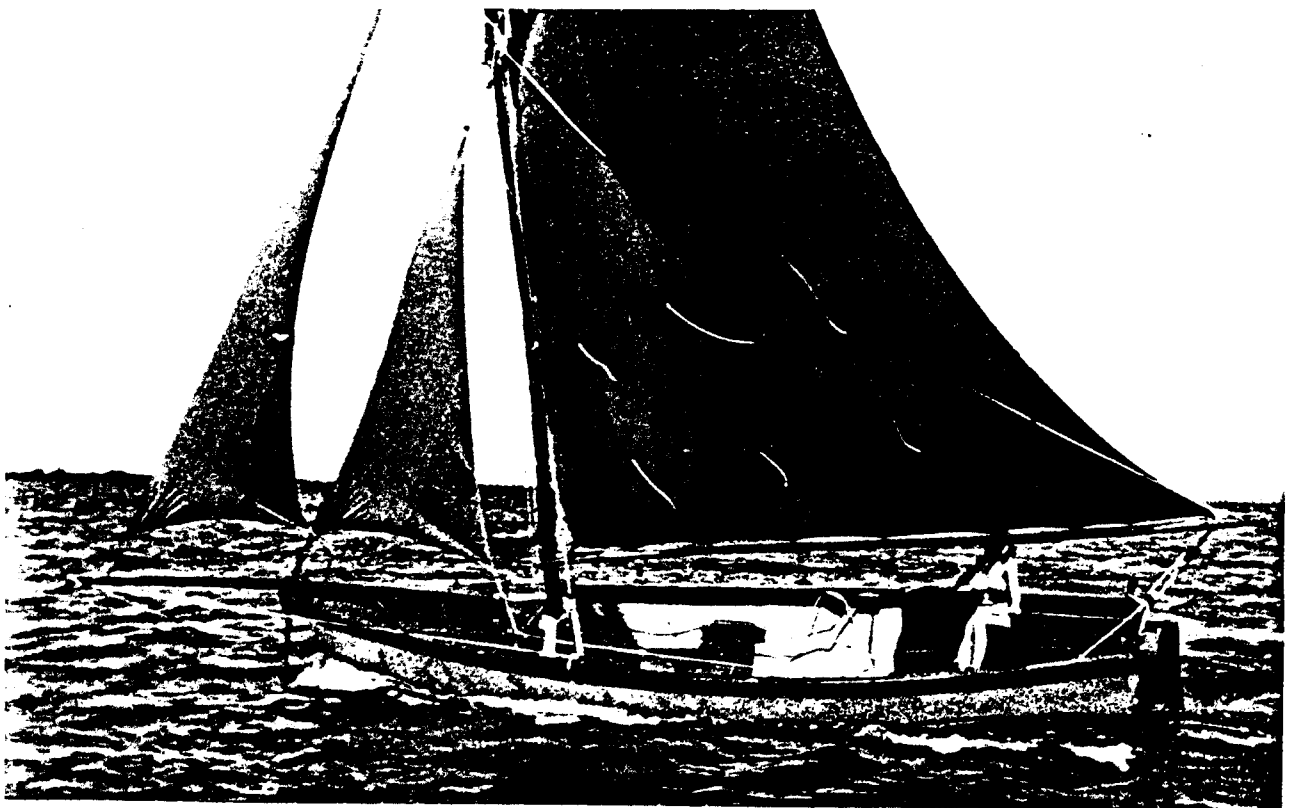


Fig. 3. Gaff rig on a 5.8 m (19 ft) fishing boat on Lake Malawi

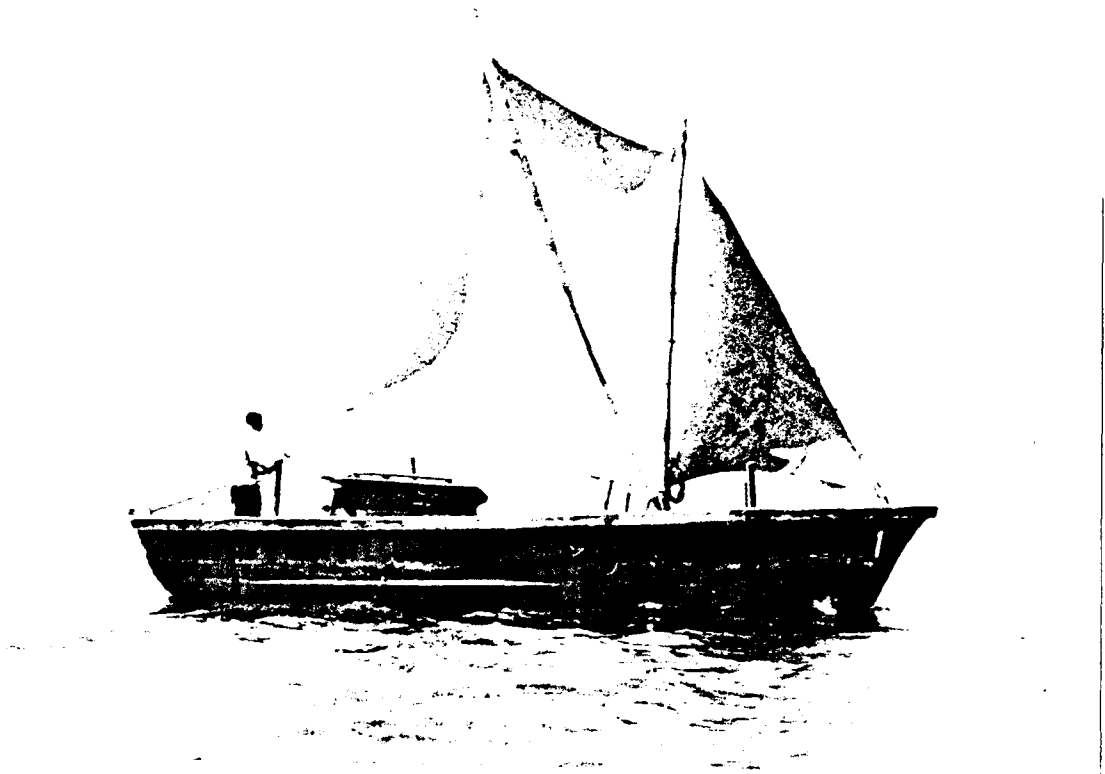


Fig. 7. 8.5 m (28 ft) fishing boat with sprit sail rig in Somalia



Fig. 8. Chinese type fully battened lug sail (reefed one batten)
on a 6.4 (22 ft) boat in Somalia

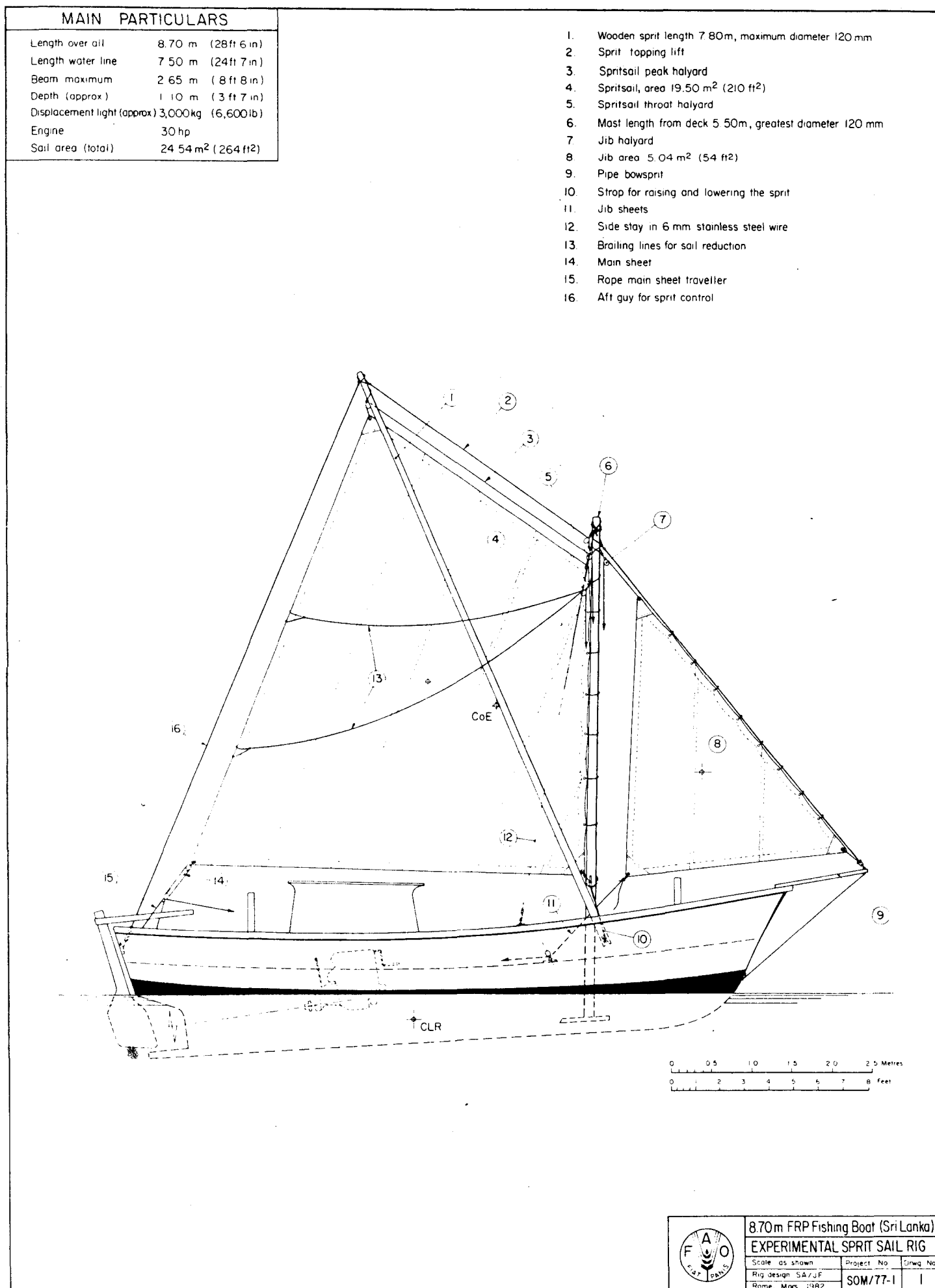


Fig. 9. Arrangement and sail plan of Fig. 7.

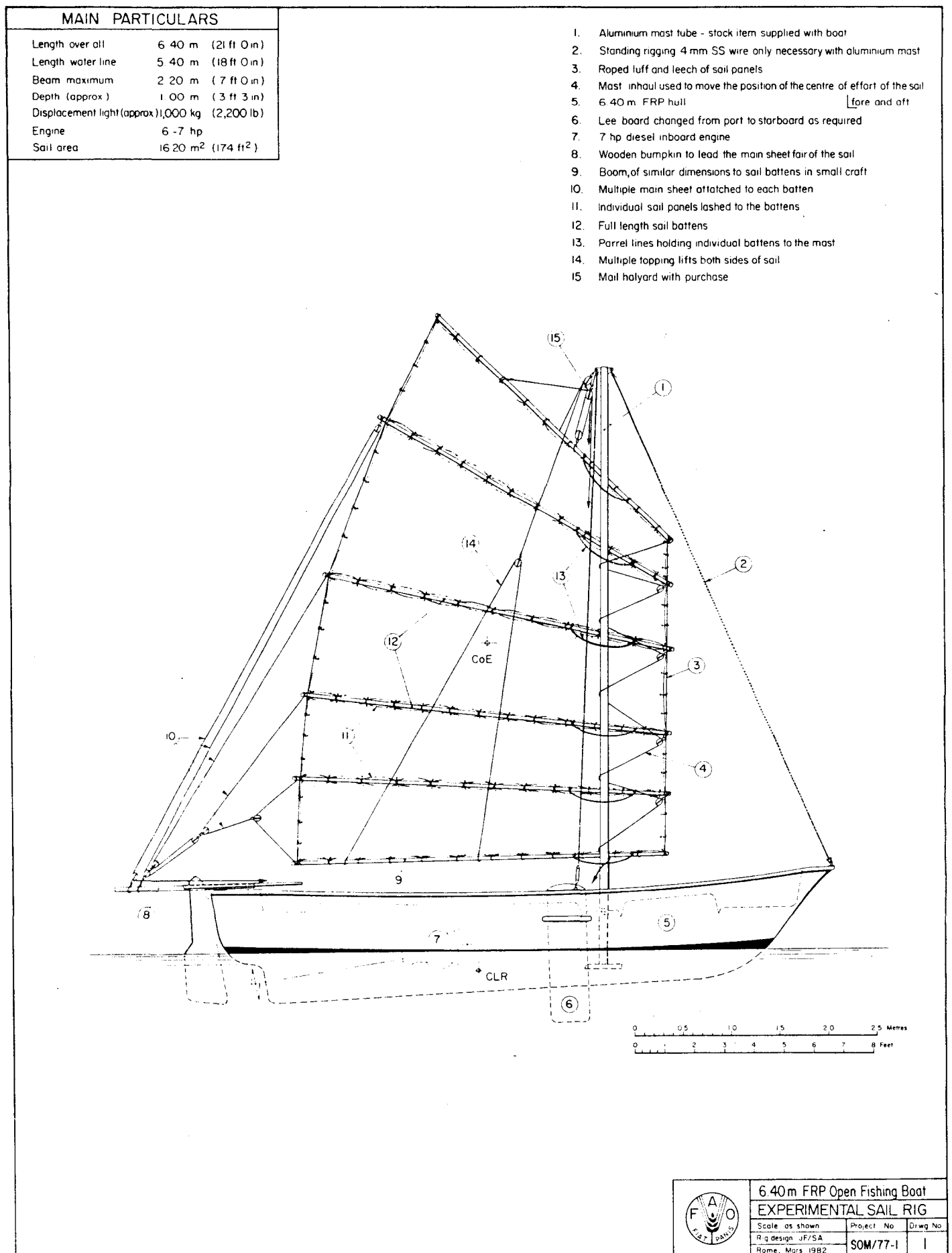


Fig. 10. Arrangement and sail plan of Fig. 8.

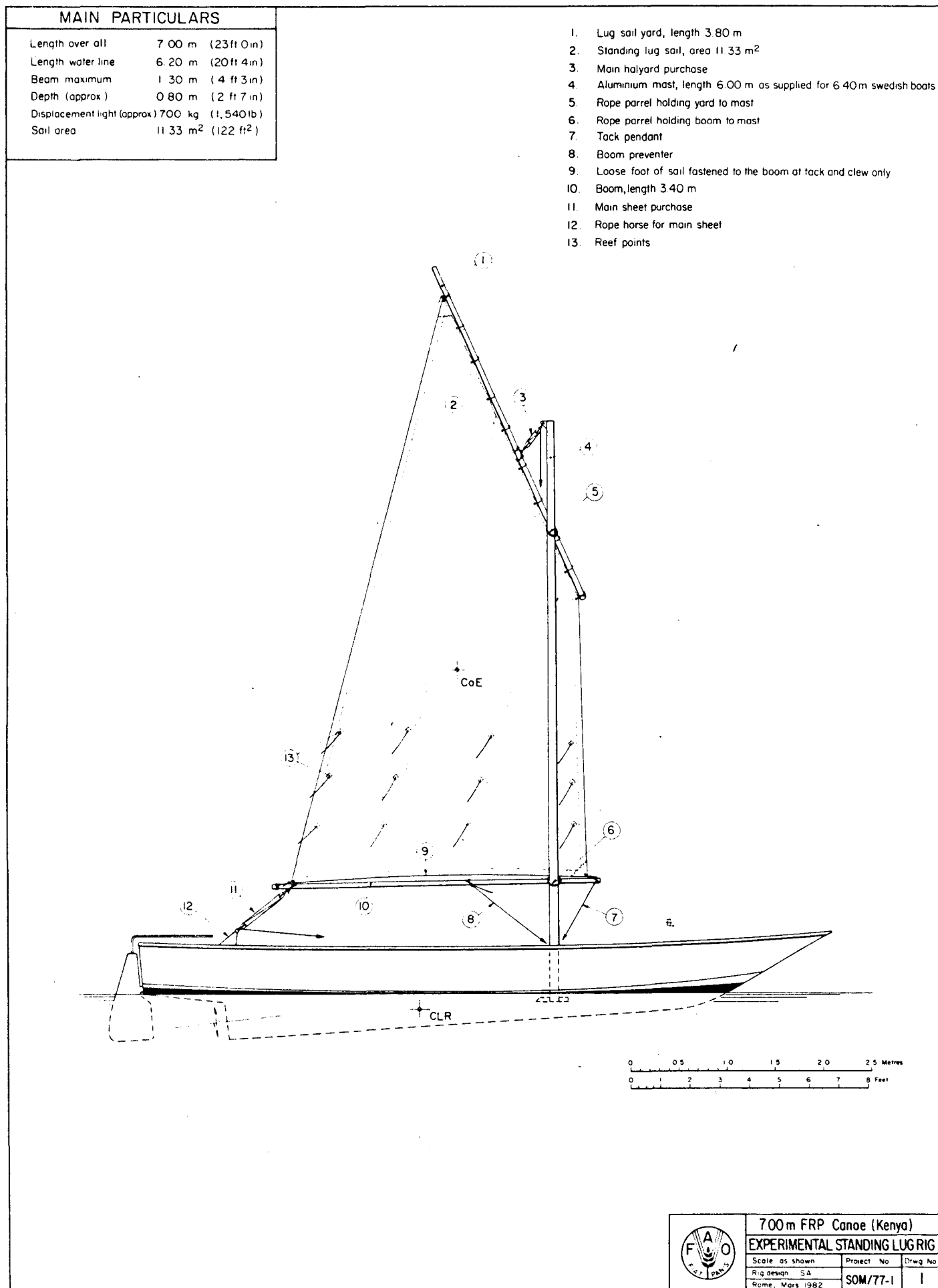


Fig. 11. Standing lug rig on a 7 m (23 ft 6 in) canoe in Somalia

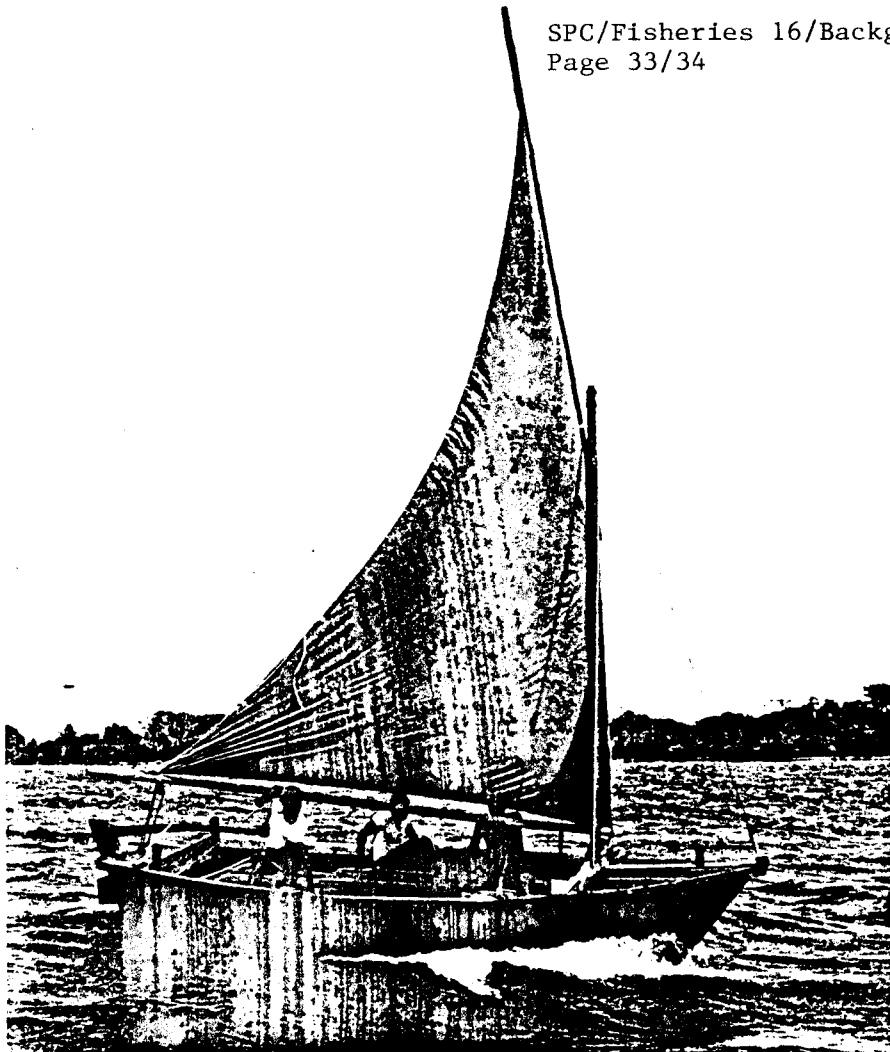


Fig. 12. 5 m (17 ft) fishing boat using a standing lug on northern Lake Malawi

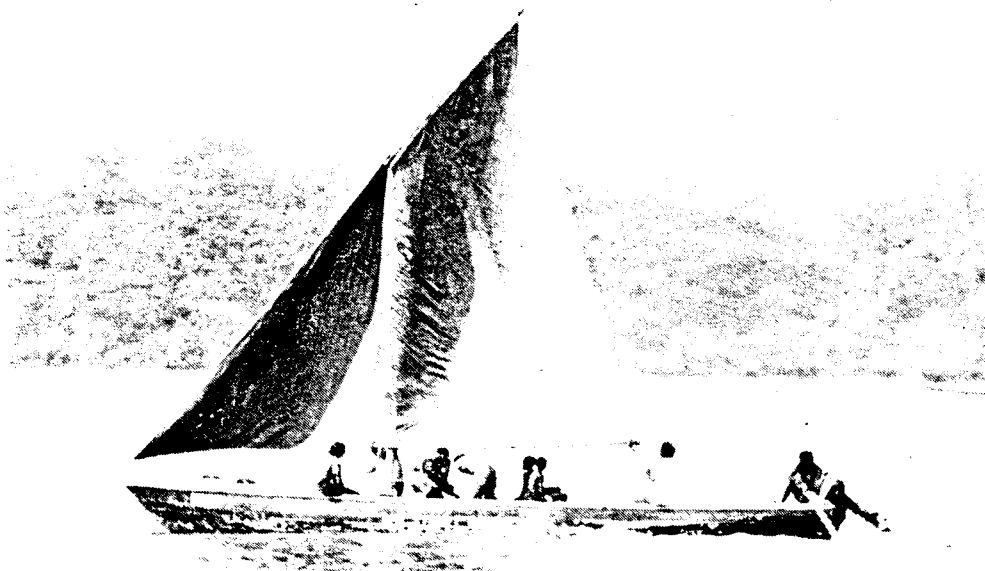


Fig. 13. A standing lug rig used on an 11 m (36 ft) canoe in Sierra Leone

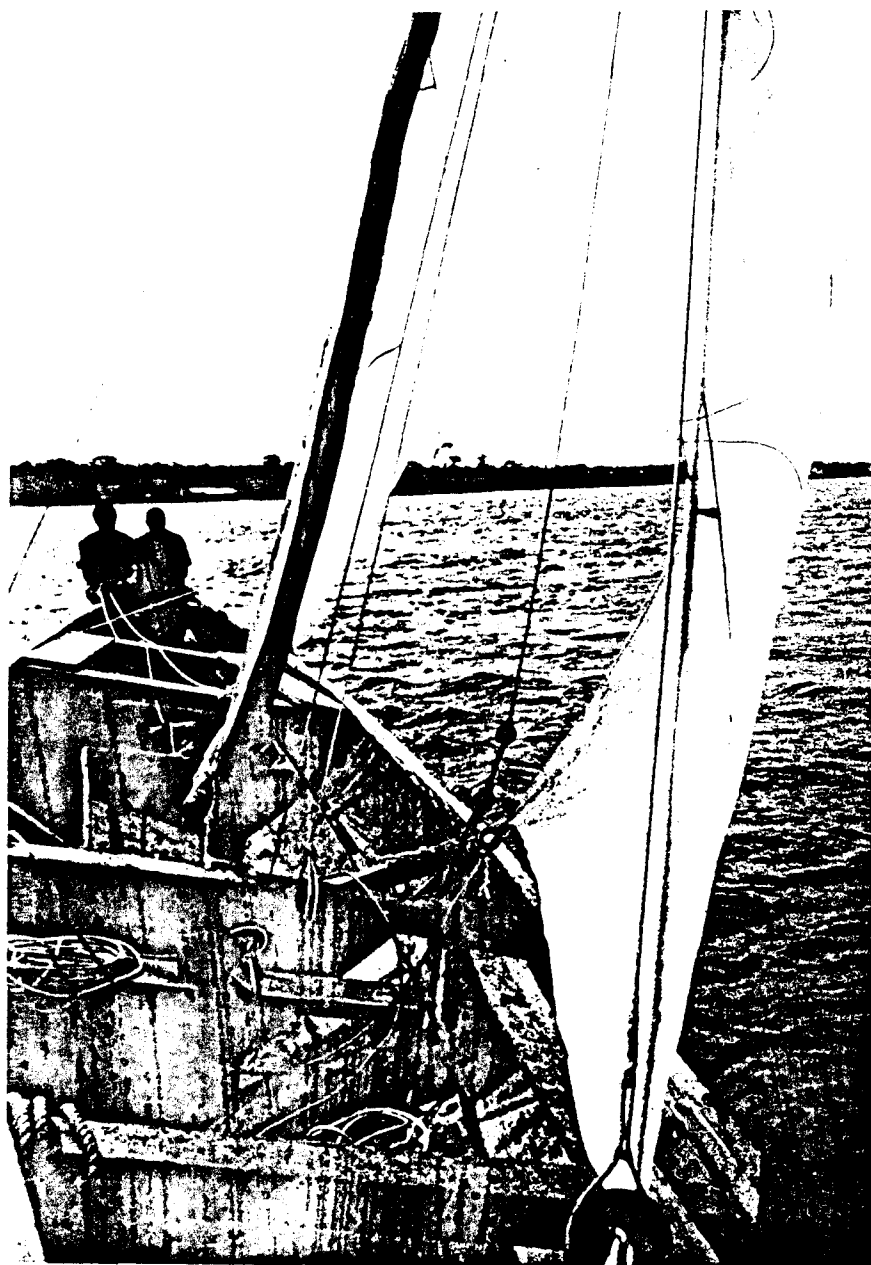


Fig. 14. View of the rig fitted to the canoe of Fig. 13

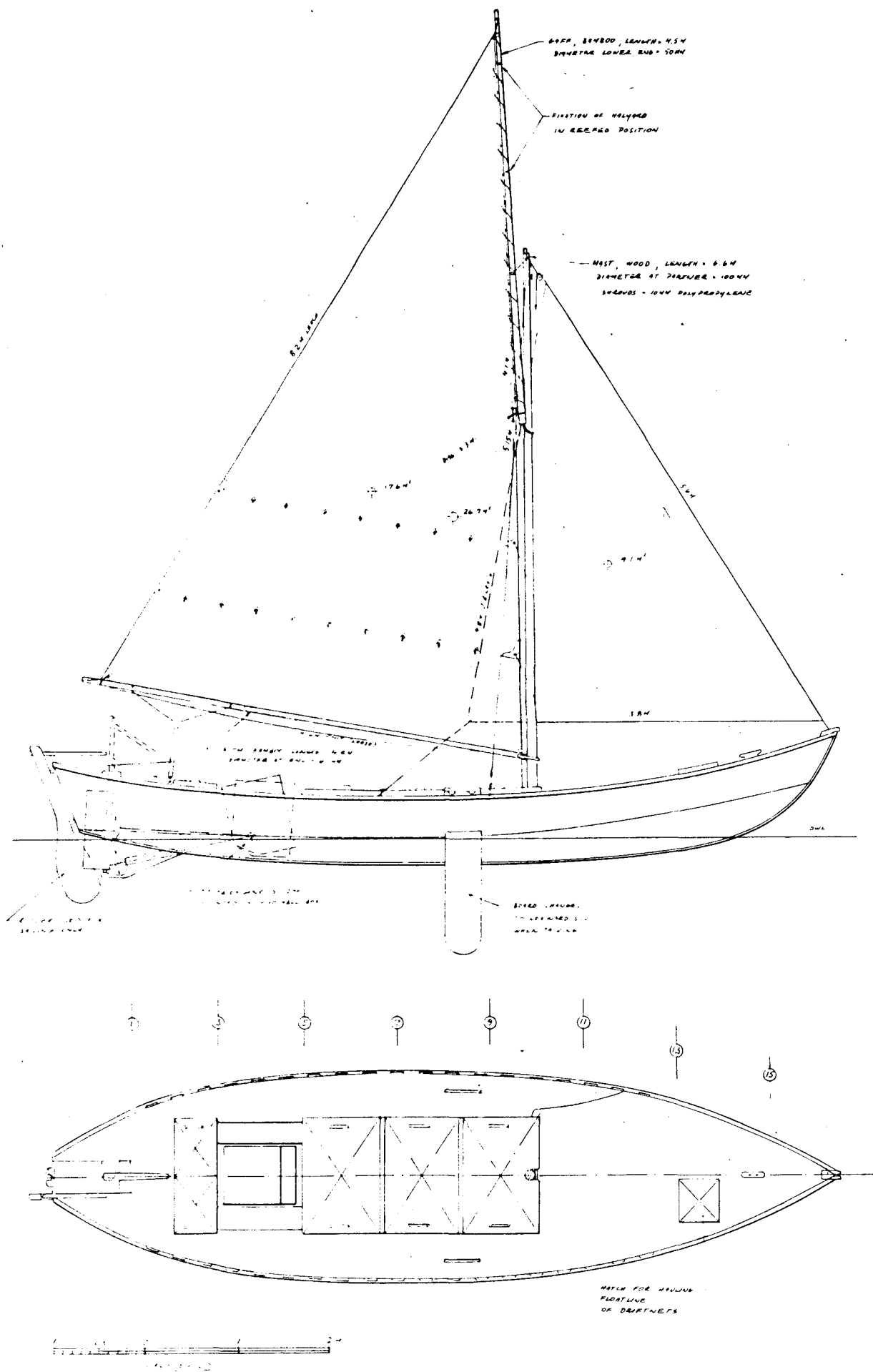
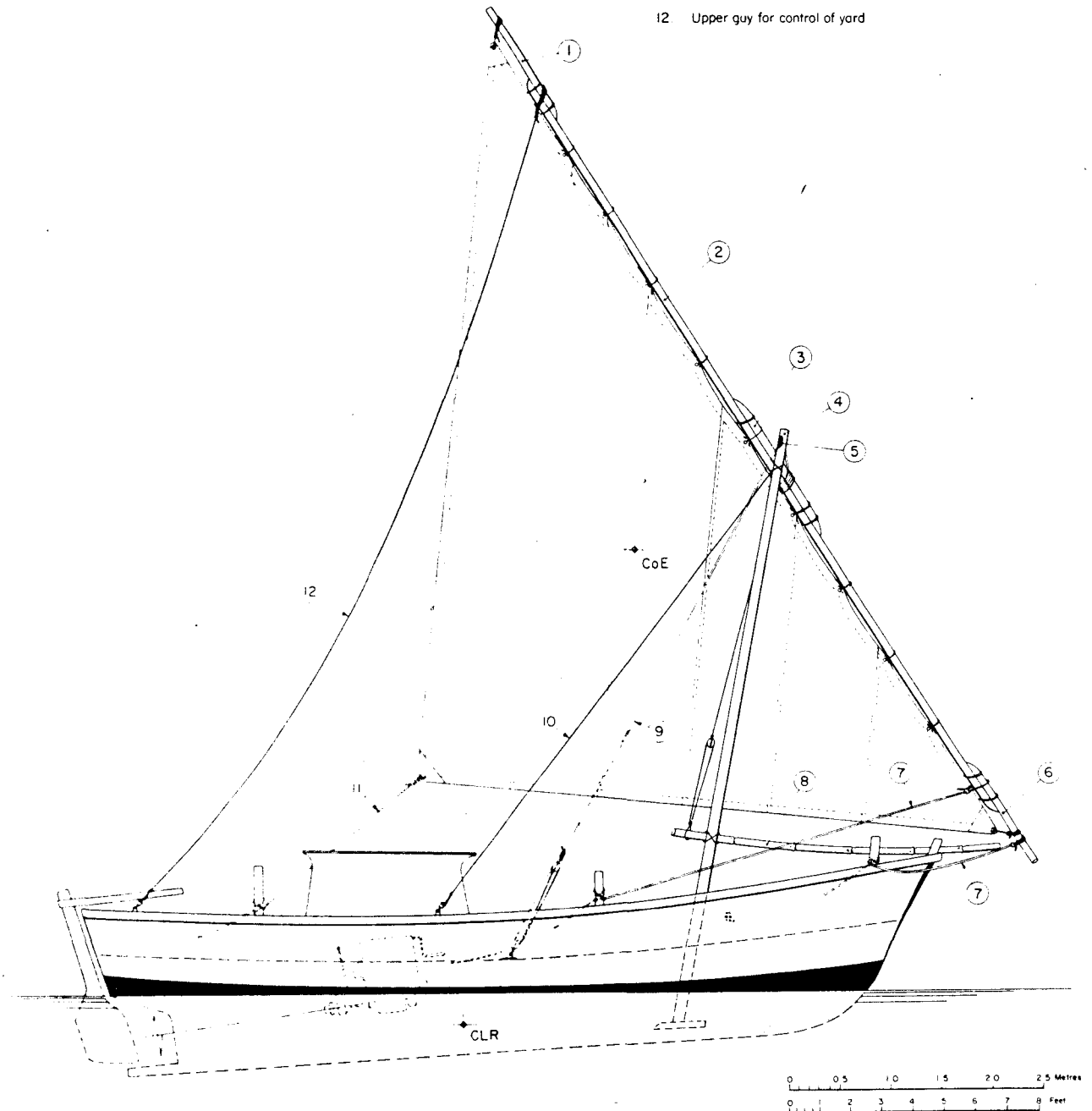


Fig. 15. A gunter rig used on an 8.4 m (28 ft) beach landing craft in India.

MAIN PARTICULARS

Length over all	8.70 m (28 ft 6 in)
Length water line	7.50 m (24 ft 7 in)
Beam maximum	2.65 m (8 ft 8 in)
Depth (approx)	1.10 m (3 ft 7 in)
Displacement light (approx)	3,000 kg (6,600 lb)
Engine	30 hp
Sail area	20.80 m ² (224 ft ²)

1. Upper yard extension
2. Wooden yard 75 mm diameter
3. Wooden reinforcement for yard - central section
4. Mast length from deck 5.20 m, maximum diameter 120 mm
5. Sheave hole at masthead for halyard
6. Lower yard extension
7. Lower yard guys
8. Bamboo "bowsprit" for yard lead
9. Rope halyard led to windward
10. Mast support stay led to windward
11. Sheet
12. Upper guy for control of yard



8.70m FRP Fishing Boat (Sri Lanka)		
EXPERIMENTAL LATEEN RIG		
Scale as shown	Project No.	Drawg No.
Rig drawn by JF/SA		
Rome, Mars 1982	SOM/77-1	1

Fig. 16. Lateen rig fitted to the same hull as that of Fig. 9.

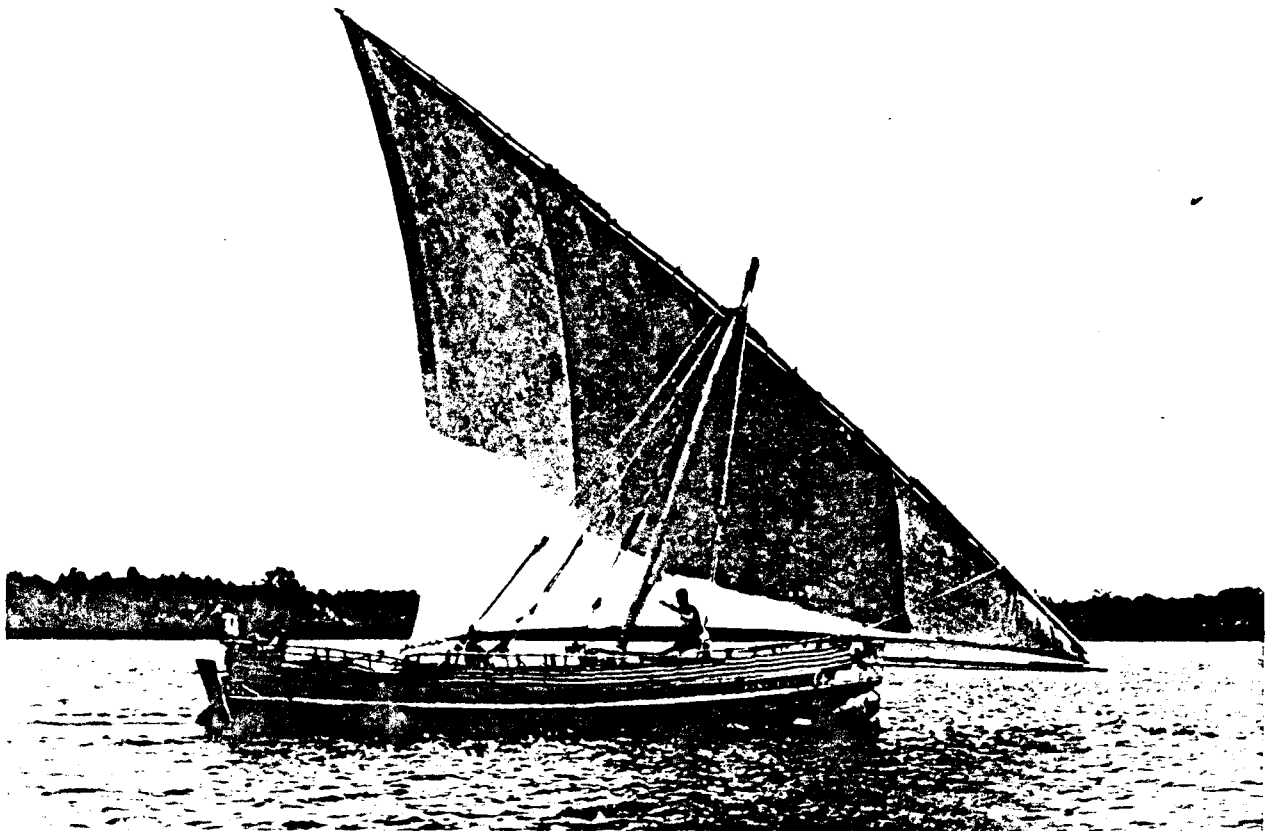


Fig. 17. A typical Kenyan unmotorised Jehazi showing the large amount of sail which can be set using the lateen rig

