

DOUBLE-RIG SHRIMP TRAWLING, ITS RIGGING, COMPARATIVE EFFICIENCY AND ECONOMICS

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A radical and revolutionary change from the hitherto employed shrimp trawling is reported for better productivity and economy in deep sea trawling with medium and large vessels. Studies carried out off Veraval with a 13.7 m. four seam shrimp trawl as conventional single-rig and two 6.8 m. four seam shrimp trawls as double-rig from a 15.2 m. fishing vessel showed an increase of 98% shrimp catch by double-rig over single-rig at 86.3 % of the power utilised by the latter. It has also been worked out, theoretically, how better this available power can be utilised for further improvement of catch. An increase of 15% head rope length in case of double-rig over the optimum single-rig gear of any vessel is recommended.

INTRODUCTION

Kristjonsson (1959) has opined application of engineering principles and rational methods as the fourth factor in addition to mechanisation, echo-fish-finding and synthetic twines for the revolutionary development of fishing industry. After the Second World War remarkable changes have taken place all over the world in trawling resulting in the development of mid-water trawls and introduction of high

opening trawls in countries like Sweden, Denmark, Germany, Netherlands and Belgium (Barracough and Needler, 1959; Larsson, 1959; Parrish, 1959; Scharfe, 1959) and double rig shrimp trawling in Mexico (Anon, 1957; Harrington, Bartlett and Higgins, 1972; Bullis and Hilton, 1972; Robas, 1959). Ringhaver (1960) correlated his findings of better efficiency of double-rig to the easy adaptability of small trawls to the irregularities of the bottom. Verhoest and Maton (1964) compared

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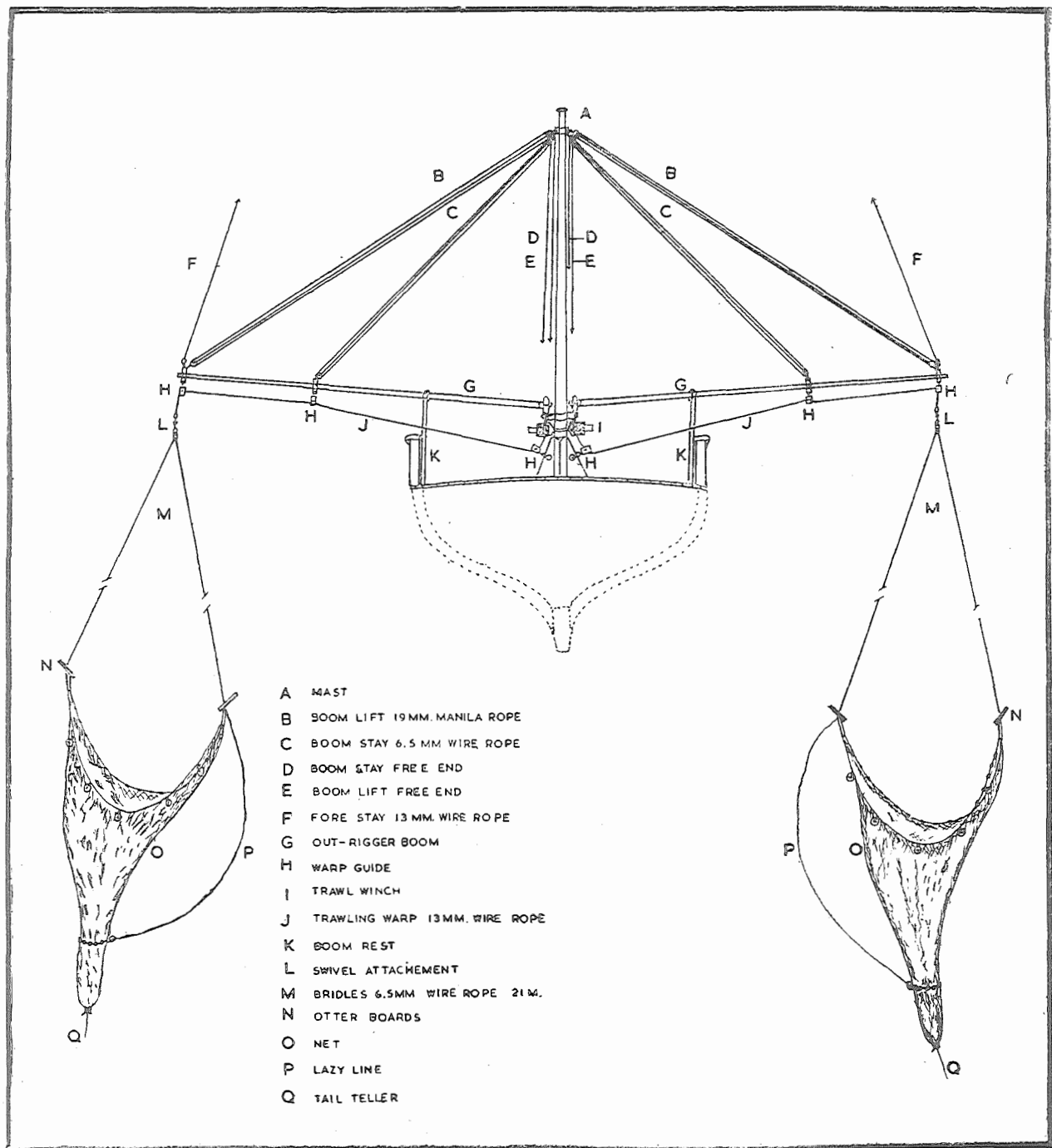


Fig. 1 Operation of Double-rig.

double-rig beam trawls with single-rig otter trawls and stated that by double-rig catch can be increased by 30%.

Studies conducted in India have re-

vealed better productivity of shrimp with smaller gear (Deshpande and Kartha, 1964; Deshpande, George and Sivan, 1964). However, ever since the introduction of mechanised fishing, trawling was confined

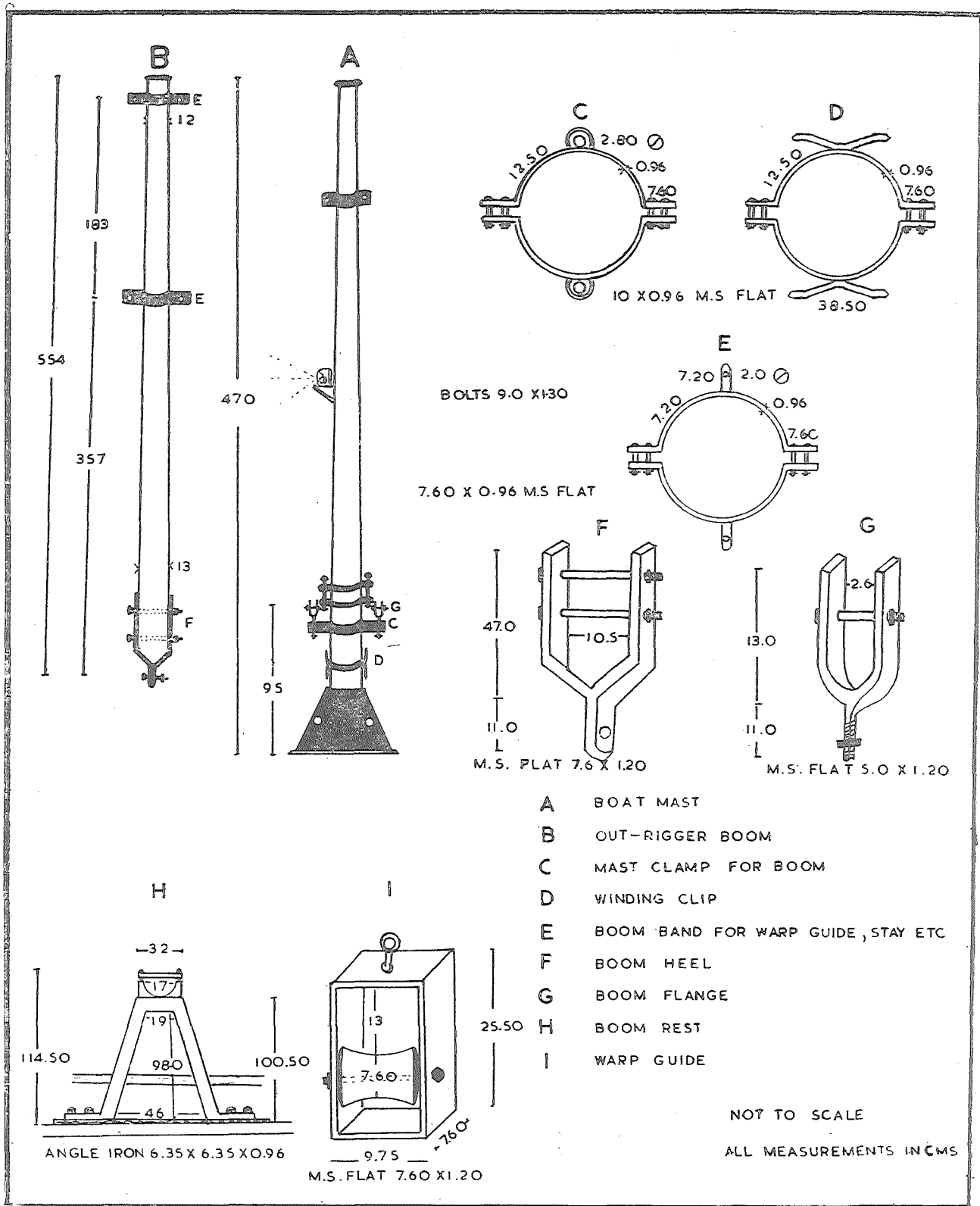


Fig. 2 Design details deck rigging accessories.

to conventional single trawl operation mainly due to the lack of medium and large vessels. The present trend of deep sea trawling with medium and large vessels necessitated a switch over to latest methods viz., double-rig and mid-water trawling. With this in view studies were undertaken on double-rig shrimp trawling to make a scientific appraisal of this method and its potentialities.

MATERIALS AND METHODS

A 15.2 m. vessel powered with 82/102 HP engine (Fishtech No. 8) was suitably rigged for the operations. Two wooden booms (Teak) of 5.54m. length and 13cm. diameter at base rigged on either side at about 20° to the horizontal using boom rests, stays *etc.* Trawl warps from the trawl winch are passed through specially made warp guides to facilitate free passage of bridles with swivel arrangements (Fig. 1 and 2).

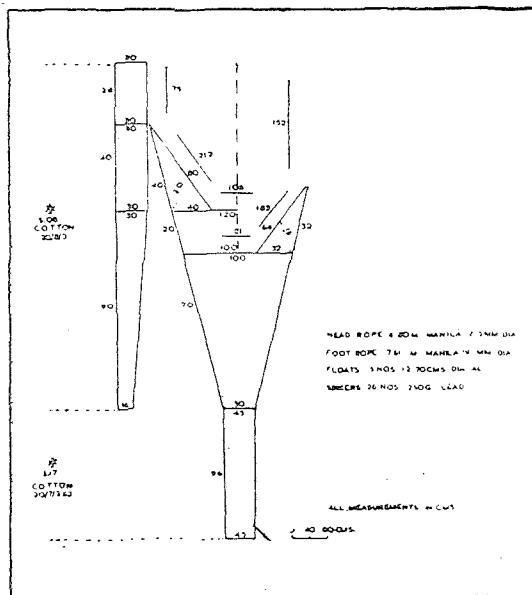


Fig. 3

Design of 6.8 m. Four-seam trawl

The gear selected were 13.7 m. four seam shrimp trawl with 140 × 63 cm. rectangular flat otter boards (Satyanarayana and Nair, 1962) for the single-rig and two 6.8 m. four seam shrimp trawls (Fig. 3) with 90 × 45 cm. rectangular flat otter boards (Satyanarayana and Nair, *op. cit.*) for double-rig operations. The single net was operated using conventional double stern gallows where as the double rig was operated with single tow warp and double bridles from the boom. The length of the bridles was kept at three times the head rope length to give sufficient spread of net without strain. A lazy line was attached to the inside otter boards for hauling in the cod end. The details of the gear used are given in Table I.

During operations booms were lowered after passing the bridles through the warp guides and the stays *etc.* tightened keeping the boom in the boom rest groove. The boom rest was provided with a locking arrangement to avoid bumping of the boom due to swells. The gear with bridles swivelled to the port and starboard side towing warps were released overboard and the excess bridles were heaved up to keep the otter boards at the boom tips. After taking the soundings and bearings the gear were released from both sides at a slow speed keeping port side net 10 m. ahead of the other. Hauling is simultaneous from both sides till the gear with less length of warp hoisted to the boom tip. The other is hoisted separately after releasing the former from the winch clutch. The lazy lines were hauled up and cod ends emptied on board.

RESULTS AND DISCUSSION

The data pertaining to 55 comparative

TABLE I

PARTICULARS OF THE GEAR

Method of operation	Net used	Head rope length m.	Foot rope length m.	Legs	Sweeps	Aluminium floats	Lead	Otter boards
Single-rig	one 13.7 m. four seam cotton	13.7 12.5mm. dia. manila	15.20 19.0mm. dia. manila	2.00 m. 12.5 & 19mm. dia. manila	5 m. 19 mm. dia. manila	9 no. 12.5 cm. dia.	50 no. 225 g. each	140×63 cm. rectangular flat 55 kg. each
Double-rig	Two 6.8 m. four seam cotton	6.80 12.5 mm. dia. manila	7.61 19.0 mm. dia. manila	1.00 m. 12.5 & 19 mm. dia. manila	2.5 m. 19mm. dia. manila	5 no. 12.5 cm. dia.	25 no. 225 g. each	90×45 cm. rectangular flat 27.5kg. each

Panicker et al.: Double-rig shrimp trawling

TABLE II
RESULTS OF COMPARATIVE FISHING TRIALS

Fishing Ground Off Veraval 20° 45' to 21° N. lat. and 70° 05' to 70° 20' E. long. between 20 and 35m. depth														
Method of operation	No of hauls	Duration hrs. min.	Speed knots	Tension (kg.)			Catch (kg.)			Catch/hr. (kg.)			Catch composition %	
				Port	Star-board	Total	Prawn	Fish	Total	Prawn	Fish	Total	Prawn	Fish
Single-rig	55	41.00	2	229.80	230.46	460.26	713.0	2320	3033	17.4	56.46	73.96	23.50	76.50
Double-rig	55	41.00	2	198.40	198.86	397.26*	1413.0	1894**	3307	34.4	46.17	80.60	42.71	57.29

*86.3% of the total resistance offered by single-rig. (Resistance is taken as the factor indicating the utilization of power of the engine for towing the gear)

**81.58% of the single-rig fish catch.

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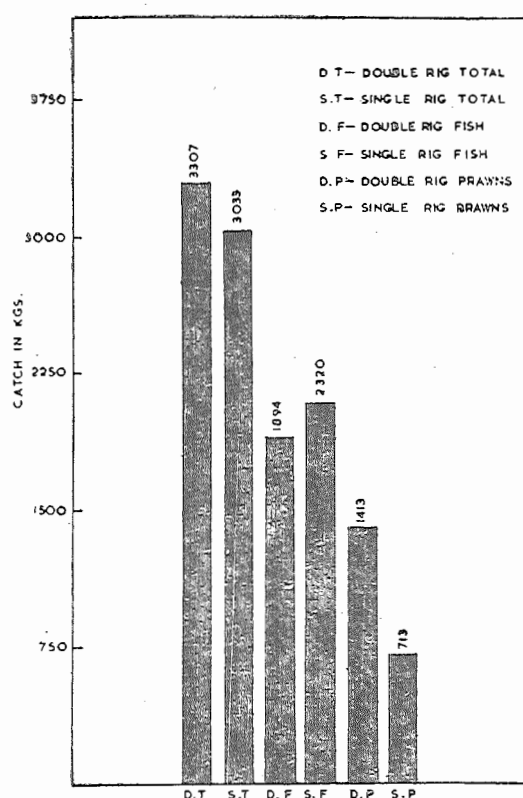


Fig. 4 : Histogram showing catch of single & double-rig.

hauls taken during 1971-72 and 1972-73 fishing seasons are given in Table II and figure 4.

The data on catch per hour of prawns and fish and tension were analysed statistically and represented in Table III.

The analysis of variance of prawns, fish and total catch clearly indicates a significant variation of prawn catch between rigs ($P \leq 0.05$). The significantly higher catch of prawns by double-rig gear can be attributed to the inherent qualities of smaller nets to adjust better to the irregularities of the bottom and better horizontal opening (Ringhaver, 1960; Verhoest and Maton *op. cit.*).

In the case of fish the trend was reverse and the single-rig catch was significantly higher ($P \leq 0.05$). The significant higher average catch per hour of fish in the single-rig than the double-rig indicates better efficiency of the former in this respect, which can be attributed to its higher vertical opening.

The analysis of variance of tension on port and starboard side indicates significant variation between riggings at 1% level. The average tension on both port and starboard side clearly indicates significantly higher tension offered by single-rig, which can be attributed to its higher vertical opening (Table II).

Figure 5 clearly indicates a higher resistance offered by the single-rig on both starboard and port side when the gear was towed with and against current. Resistance offered by the double-rig gear was 13.7% less than that of single-rig. This available margin of power (Traung, 1964) can be utilised to increase landings in three different ways, namely by increasing the head rope length, vertical height or speed. Extent to which these three factors can be increased from the existing gear are worked out theoretically using the following three formulae.

$$l_1 = 1 + \frac{(r_1 - r_2) l}{r_2} \dots 1$$

$$p_1 = \left\{ 1 + \frac{(r_1 - r_2) l}{r_2} \right\} p/l \dots 2$$

$$f_1 = \left\{ 1 + \frac{(r_1 - r_2) l}{r_2} \right\} f/l \dots 3$$

$$c_1 = \left\{ 1 + \frac{(r_1 - r_2) l}{r_2} \right\} \frac{p + f}{l} \dots 4 \text{ or}$$

$$h_1 = h + \frac{(r_1 - r_2) h}{r_2} \dots 1$$

TABLE III
ANALYSIS OF VARIANCE OF CATCH AND TENSION

Catch												
Source	Prawns				Fish				Total			
	SS	DF	MS	F	SS	DF	MS	F	SS	DF	MS	F
Total	22.6339	109	—	—	10.8350	109	—	—	12.0466	109	—	—
Between riggings	0.6912	1	0.6912	6.55*	0.3470	1	0.3470	4.41*	0.0285	1	0.0285	0.3450
Between hauls	16.2419	54	0.3007	2.85*	6.2420	54	0.1155	1.47*	7.5571	54	0.1399	1.6037
Error	5.7008	54	0.1055	—	4.2460	54	0.0786	—	4.4610	54	0.0826	—

Tension									
Source	Port side				Starboard				
	SS	DF	MS	F	SS	DF	MS	F	
Total		105625	51	—		107698.0	51	—	—
Between riggings		12774	1	12774.00		12962.0	1	12962.00	18.45†
Between hauls		77708	25	3108.32		77173.5	25	3086.94	4.39†
Error		15143	25	605.72		17562.5	25	702.50	

*Indicates 5% level of significance

† Indicates 1% level of significance.

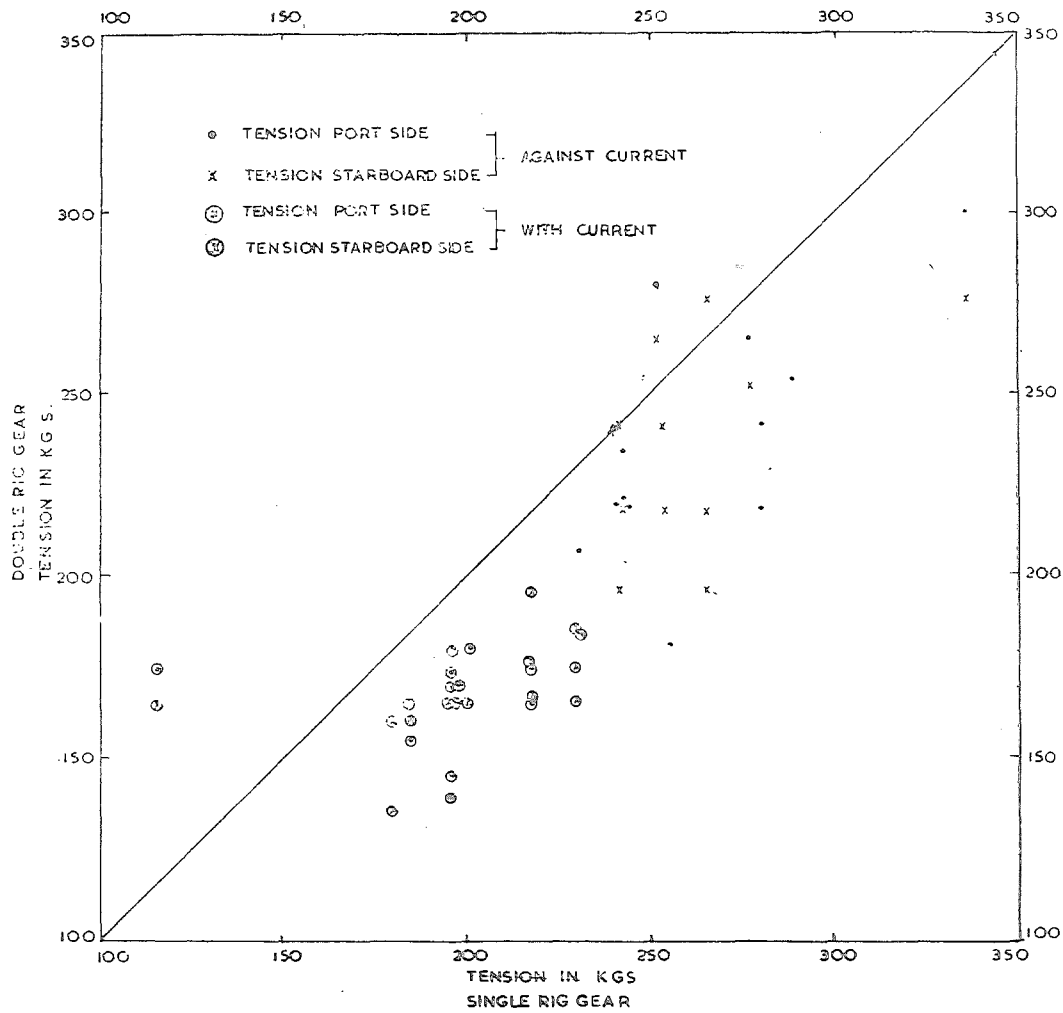


Fig. 5 : Graph showing resistance of single & double-rig gear

$p_2 = p$ as there is no increase in the horizontal opening ... 2

$$f_2 = \left\{ h + \frac{(r_1 - r_2) h}{r_2} \right\} f/h \quad \dots 3$$

$$c_2 = p + \left\{ h + \frac{(r_1 - r_2) h}{r_2} \right\} f/h \quad \dots 4 \text{ or}$$

$$v_1 = v \sqrt{r_1 / r_2} \quad \dots 1$$

$$p_3 = (v \sqrt{r_1 / r_2}) p/v \quad \dots 2$$

$$f_3 = (v \sqrt{r_1 / r_2}) f/v \quad \dots 3$$

$$c_3 = (v \sqrt{r_1 / r_2}) \frac{p + f}{v} \quad \dots 4$$

where l and l_1 = total head rope length of existing double-rig and theoretical double-rig respectively.

r_1 and r_2 = resistance of single and double-rig gears (resistance is taken as the factor indicating the utilization of power for towing the gear)

h and h_1 = vertical height of existing and theoretic double-rig.

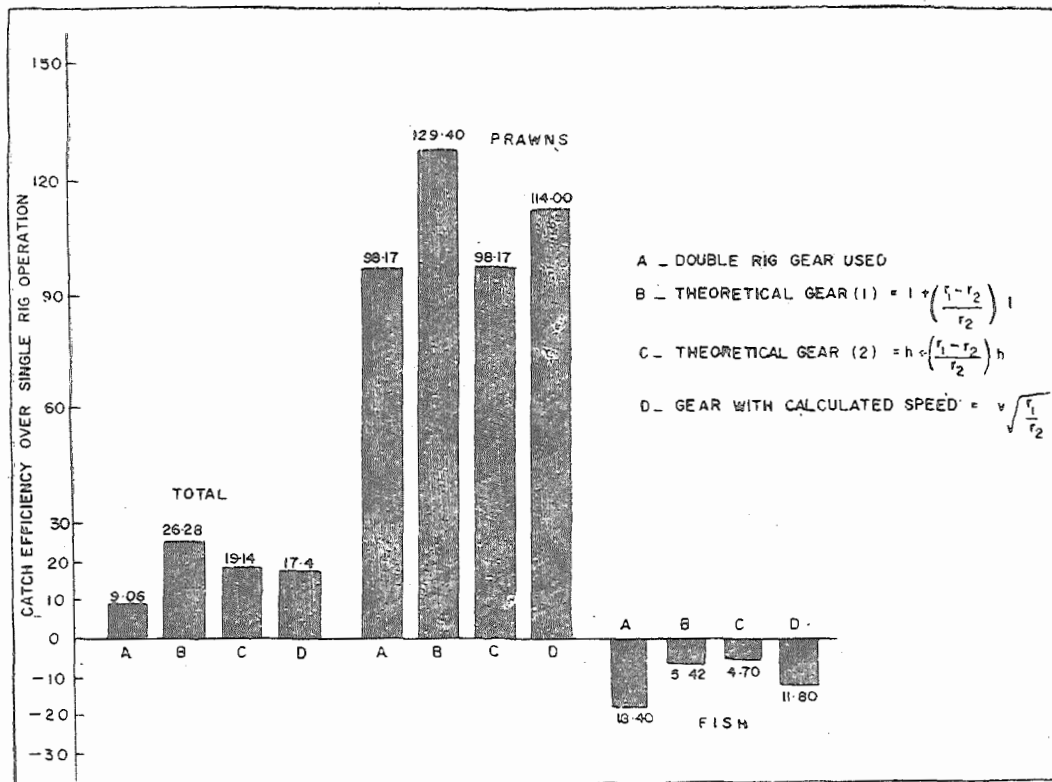


Fig. 6: Histogram showing comparative efficiency of experimental double-rig and theoretical gear with increased head-rope, vertical height and speed over single-rig.

v and v_1 = present and theoretical speed.

p, p_1, p_2, p_3 = prawn catch

f, f_1, f_2, f_3 = fish catch

c, c_1, c_2, c_3 = total catch

From the above equations it is calculated that head rope length can be increased up to 15.84% keeping vertical height and speed constant or vertical height by 16.25% with speed and head rope length constant or 8% of the present speed keeping the other two constant.

Figure 6 showing the effect of the above, clearly indicates that an increase in the head rope is more productive.

From the above it is reasonable to conclude that double-rig trawling is more productive as a whole and its efficiency in shrimp catching is almost double than that of single-rig. The low power utilization of the double-rig (86.3%) clearly shows a scope for increasing the total head rope length by 15 to 16% of the optimum single-rig trawl for any vessel. Yet another important aspect of double-rig in lieu of single-rig is the easier handling of gear and the comparative low gear replacement expenses.

The present fishing trials of double-rig trawling was carried out with the limited facilities available at that time. During the course of fishing, the authors

felt problems such as stability of the vessel and operational difficulties. Due to the above difficulties double-rig operations were confined to a period of three months in a season (December to February) when the sea is calm. To overcome those short comings and to extend the period of operations throughout the season the following modifications in rigging are suggested.

- 1) The heavy wooden out-rigger booms should be replaced by reinforced iron pipes of 8 to 10 cm. dia. and 6 to 8 mm. thickness according to the size of the gear used, vessel and its H.P.
- 2) The boom rest height should be so adjusted to get 30° from the horizontal for the booms during operation.
- 3) Safety arrangements to release the boom tip warp guide to lead the warp from the centre warp guide position using a safety runner block hook up for the former warp guide to the boom tip.
- 4) The position of the centre warp guide should also be kept just outside the boom stay.
- 5) Replacement of the present trawl winch by side drum winch preferably with a central drum for try net.

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