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Technology Induced Productivity in Fisheries

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Artisanal fisheries in Cochin are characterised by the presence of three types of craft operations (large motorised crafts, small motorised crafts and non-motorised crafts) representing three different technological gradations. The study investigated the technological gradations vis-a-vis capital and labour productivity. It was observed that more sophisticated the technology, higher are the costs as well as gross returns. Though every increase in capital was accompanied by an increase in labour, capital increase per labour was not proportionate, i.e. increase in capital is more than increase in labour, showing a labour saving character in the process of technological sophistication. In terms of productivity, capital productivity declines as capital intensity increases. Optimum use of capital in terms of productivity does not occur in fish harvest technologies.

Key words: Capital productivity, labour productivity, non motorised craft, motorised craft, capital - labour ratio

Harvest technologies in fisheries are primarily designed to enhance the physical and monetary returns per factor input employed. Technologies are designed both to suit the catch efficiency with reference to species caught and the physical environments of the fisheries. As a result, most fishing locations are known to encourage and sustain several different technologies simultaneously. Fisheries around Cochin are dominated by relatively capital intensive large motorised crafts (>12m), small sized motorised crafts (<12m) and non motorised crafts. It is obvious that these three types of craft operations represent three different levels of technology within the artisanal fisheries. The gradation involves different levels of investment per fishing unit as well as crew size. It will be interesting to investigate whether this gradation in capital and labour use has any significant bearing on the rate of return on labour and capital.

The three categories represent three levels of technological sophistication. The non motorised craft represents the least improved of the technologies. Operating in the near shore waters of the sea or in the backwaters, and the input in terms of capital and material are minimal. Small motorised crafts are fitted with one engine each and use a variety of gill nets. The large motorised crafts on the other hand have a large complement of nets and are fitted with 2-3 motors each. It is to be borne in mind that the above mentioned technological adoption has been at the behest of the fishers themselves and not as a result of any organised extension, taking into account cost-benefit analyses. The consequences of such suo motu adoption thus invite immediate attention and need critical examination.

Studies on the economic aspects of motorised traditional craft invariably focus on the rate of return on investment only. Anon (1993), Annamalai & Kandoran (1990) and Manohardoss *et al* (1997) had gone into the profitability and feasibility of the motorised crafts as fishing enterprises. The impact of different grades of technological sophistication on the factor combinations and factor productivities is an aspect of the innovation that requires systematic exposition. This paper aims to find out capital-labour ratios for different grades of technologies and the bearings, if any, of these ratios on capital and labour.

Materials and methods

For the purpose of evaluating technology induced changes in productivity, three distinct harvest technologies that are important off Cochin coast have been selected. These are non motorised craft, small motorised craft (<12m) and large motorised craft (>12m).

In collecting cost and revenue data, major emphasis was laid on recording only the observed data in respect of revenues accruing to fishing trips. These revenue data were collected once a week for a period of two years, 1995 and 1996, by recording the observable auction prices at the landing site of Cochin and Vypeen for the three classes of fishing crafts. This gives a high degree of reliability to the figures so far as revenue is concerned. On the side of cost, data collection was carried out by interview method. Productivity as reflected in the rate of return on investment, output-labour ratio and output-capital ratio were computed.

The ratios were arrived at as follows:

Capital - labour ratio =
Average investment/Average crew size

Output - labour ratio =
Average revenue/Average crew size

Output - capital ratio =
Average revenue/Depreciation

Returns to investment =
Profit / Investment x 100

Results and Discussion

Cost and returns in respect of the three harvest technologies are presented in Tables 1-3. Total variable cost for technologies - 1, 2 and 3 were Rs. 182, Rs. 1,278 and Rs. 3,288 respectively, signifying that variable costs under the three technologies follow the

Table 1. Costs and returns in non motorised craft/trip

Month	Average Revenue	Labour Cost	Capital Cost		Total Cost	Profit
			Depreciation	Interest		
	(Rs.)	(Rs.)	(Rs.)	(Rs.)	(Rs.)	(Rs.)
Mar-95	107.00	71.33	3.75	5.63	80.71	26.29
Apr-95	189.29	126.19	3.75	5.63	135.57	53.72
May-95	175.53	117.02	3.75	5.63	126.40	49.13
Jun-95	213.34	142.23	3.75	5.63	151.61	61.73
Jul-95	190.56	127.04	3.75	5.63	136.42	54.14
Aug-95	133.29	88.86	3.75	5.63	98.24	35.05
Sep-95	161.70	107.80	3.75	5.63	117.18	44.52
Oct-95	125.00	83.33	3.75	5.63	92.71	32.29
Nov-95	1705.00	1136.67	3.75	5.63	1146.05	558.95
1995 average	333.41	222.27	3.75	5.63	231.65	101.76
Jan-96	149.35	99.57	3.75	5.63	108.95	40.40
Feb-96	124.50	83.00	3.75	5.63	92.38	32.12
Mar-96	146.00	97.33	3.75	5.63	106.71	39.29
Apr-96	182.55	121.70	3.75	5.63	131.08	51.47
May-96	165.67	110.44	3.75	5.63	119.82	45.84
Jun-96	193.00	128.67	3.75	5.63	138.05	54.95
Jul-96	334.88	223.25	3.75	5.63	232.63	102.25
Aug-96	244.25	162.83	3.75	5.63	172.21	72.04
Sep-96	360.00	240.00	3.75	5.63	249.38	110.62
1996 average	211.13	140.75	3.75	5.63	150.13	61.00
(1995-96) average	272.27	181.51	3.75	5.63	190.89	81.38

Table 2. Costs and returns in small motorised craft/trip

Month	Average Revenue	Total Variable Cost			Capital Cost			Total Cost	Profit
		Fuel	Labour	Total	Maintenance	Interest	Depreciation		
	(Rs)	(Rs)	(Rs)	(Rs)	(Rs)	(Rs)	(Rs)	(Rs)	(Rs)
1	2	3	4	5	6	7	8	9	10
Jun-95	1781.33	247.33	767.00	1014.33	86.67	65	43	1209.00	572.33
Jul-95	2987.50	297.00	1345.25	1642.25	86.67	65	43	1836.92	1150.58
Aug-95	1431.25	255.16	588.04	843.21	86.67	65	43	1037.88	393.37
Sep-95	1816.67	247.33	784.67	1032.00	86.67	65	43	1226.67	590.00
Oct-95	1287.50	247.33	520.09	767.41	86.67	65	43	962.08	325.42
Nov-95	1895.00	247.33	823.84	1071.16	86.67	65	43	1265.83	629.17
1995 average	1866.54	256.91	804.82	1061.73	86.67	65	43	1256.40	610.15
Jan-96	1850.00	247.33	801.34	1048.66	86.67	65	43	1243.33	606.67
Feb-96	790.00	284.25	252.88	537.13	86.67	65	43	731.80	58.21
Mar-96	1229.50	284.25	472.63	756.88	86.67	65	43	951.55	277.96
Apr-96	1152.50	286.38	433.06	719.44	86.67	65	43	914.11	238.39
May-96	1410.00	297.00	556.50	853.50	86.67	65	43	1048.17	361.83
Jun-96	932.67	294.17	319.25	613.42	86.67	65	43	808.09	124.58
Jul-96	9279.75	354.25	4462.75	4817.00	86.67	65	43	5011.67	4268.08
Aug-96	3702.50	359.50	1671.50	2031.00	86.67	65	43	2225.67	1476.83
Sep-96	3730.00	397.00	1666.50	2063.50	86.67	65	43	2258.17	1471.83
1996 average	2675.21	311.57	1181.82	1493.39	86.67	65	43	1688.06	987.15
(1995-96) average	2270.88	284.24	993.32	1277.56	86.67	65	43	1472.23	798.65

difference in their investment outlay. The figures of total cost followed the same pattern. From the point of view of cost therefore, more sophisticated the technology, higher was the cost of operation.

From the revenue side, the total revenue unambiguously followed the pattern of cost. Thus Technology -1 earned a gross revenue of Rs. 272 per trip, Technology -2 Rs. 2,271 a trip and Technology -3 Rs. 4,987a trip. Thus as in the case of cost, more sophisticated the technology, higher was the gross return per trip.

The above mentioned relationship between different grades of technologies and their corresponding cost and revenues do not go beyond the gross figures. In terms of productivity of individual factors of labour and capital the technologies show divergent results.

In terms of economics, the difference in the three technologies is reducible to their difference in capital-labour ratio as represented in Table 4.

Non motorised craft requires Rs. 0.075 lakh per labour. The corresponding capital for small motorised craft was Rs. 0.26 lakh and for large motorised craft it was Rs. 0.14 lakh. The non motorised craft, though viewed as a primitive enterprise, did not show a very great disparity in its capital use per labour as compared to large motorised craft. Capital- labour ratio was double for the large motorised craft.

In terms of capital-labour ratio, large motorised craft was less costly per labour employed as compared to small motorised craft. The small motorised craft required almost twice as much capital per labour as the large craft. This was largely accounted by the fact that the crew size was invariably less than what the craft could use. The small motorised crafts were owned and controlled either by individual fishermen or by a fisher family. Also observed was a tendency to

Table 3. Costs and returns in large motorised craft/trip

Month	Average Revenue	Total Variable Cost			Capital Cost			Total Cost	Profit
		Fuel	Labour	Total	Maintenance	depreciation	Interest		
	(Rs)	(Rs)	(Rs)	(Rs)	(Rs)	(Rs)	(Rs)	(Rs)	(Rs)
Jun-95	4820.00	1369.65	2070.21	3439.86	266.67	133.00	200.00	4039.53	780.47
Jul-95	3985.00	697.07	1972.76	2669.83	266.67	133.00	200.00	3269.50	715.50
Aug-95	3662.50	697.07	1779.26	2476.33	266.67	133.00	200.00	3076.00	586.50
Sep-95	2318.75	697.07	973.01	1670.08	266.67	133.00	200.00	2269.75	49.00
Oct-95	2800.00	697.07	1313.19	2010.25	266.67	133.00	200.00	2609.92	190.08
1995 average	3517.25	831.58	1621.69	2453.27	266.67	133.00	200.00	3052.94	464.31
Jan-96	2800.00	697.07	1261.76	1958.83	266.67	133.00	200.00	2558.50	241.50
Feb-96	1880.00	509.00	822.60	1331.60	266.67	133.00	200.00	1931.27	-51.27
Jun-96	1730.00	594.00	681.60	1275.60	266.67	133.00	200.00	1875.27	-145.27
Jul-96	20236.75	646.50	11754.15	12400.65	266.67	133.00	200.00	13000.32	7236.43
Aug-96	5635.00	659.00	2985.60	3644.60	266.67	33.00	200.00	4244.27	1390.73
1996 average	6456.35	621.11	3501.14	4122.26	266.67	133.00	200.00	4721.93	1734.42
average (1995-96)	4986.80	726.35	2561.41	3287.76	266.67	133.00	200.00	3887.43	1099.37

restrict the crew members to the family itself, obviously to secure a higher share per labour. On the other hand the large crafts were invariably owned by a sizeable team of fishermen, due to which the size of the crew could not be cut short for individual advantage. On an average, a larger craft requires about Rs. 6500 per labour as an additional investment. But technological advantage in return for this additional capital investment is in the form of larger reach, quick mobility and faster turn of the catch to the market. These advantages convert themselves into very high returns.

Table 4. Capital - labour ratio of different fishing units

Unit	Average investment (Rs. Lakh)	Average crew size	Capital - labour ratio
Non motorised	0.15	2	0.075
Small motorised (<12m)	1.30	5	0.26
Large motorised craft (>12m)	3.20	23	0.14

The larger crafts were able to raise their peak season revenue per trip to as high as Rs. 84,000 and the smaller motorised craft to Rs. 50,000. However, technology has not succeeded in raising the lean period catch to any substantial level. The income per trip for the larger craft could be as low as Rs. 700 and for the smaller craft, Rs. 250. It should be noted that gross revenue of Rs. 50,000 or more was accruing to motorised craft only during the period of monsoon.

Table 5. Variations in cost and revenue in the three types of fishing vessals.

Unit	Range of variation in final cost (Rs.)		Range of variation in final revenue (Rs.)	
	Lowest	Highest	Lowest	Highest
2	3	4	5	6
Non motorised craft	–	–	30	1000
Small motorised craft (<12m)	192	842	250	49700
Large motorised	434	1614	700	83900

In terms of input of factors, Technology-1 combined the factors of labour and capital as Rs. 0.15 lakh worth of investment to employ two labour. Technology-2 combined Rs. 1.3 lakh worth of investment with five units of labour and Technology-3 combined Rs. 3.2 lakh worth of investment with 23 units of labour as given in Table 6.

It was easily observed that the labour use was not proportionate to capital in the three technologies. Keeping factor use in Technology-1 as a base, Technology-2 showed

867% increase in capital; whereas increase in labour use was only 250%. Again, Technology-3 showed an increase of 2133% in capital and only 1150% increase in labour use. In both these cases, capital augmentation was more than double the labour augmentation. Consequently these technologies have the unmistakable character of labour saving techniques. In view of this differential cost structure that accompanies every innovation, the factor productivity under different technological regimes acquires critical importance.

Table 6. Capital - Labour proportionality across the three technologies

Unit	Capital investment (Rs. Lakhs)	Labour	
		Actual	Required for capital labour proportionality
Non motorised craft	0.15	2	2
Small motorised craft (<12m)	1.30	5	17
Large motorised craft (>12m)	3.20	23	43

Productivity of capital, the standard measure of rate of return on investment, for Technology-1 was 54% (Table 1) for Technology-2 61% (Table 2) and Technology-3, 34% (Table 3). Rate of return from Technology-3 was less than that from Technology-1 which was clearly the most primitive of the three technologies. Returns on investment is something more than a mere return on capital. Profits being the residuary reward, are to be primarily attributed to the entrepreneurial factor. Factor productivity has to be strictly derived from using production function analysis, especially multiple regression techniques. But it was observed that there was no specifiable relation between input and output in fish harvest operations thereby techniques like multiple regression failed to result in good fit rendering it inapplicable to production function analysis. As an alternative measure of factor productivity, output-input ratios were worked out for labour and capital separately.

Considering output input ratio (O/C ratio) of capital it may be seen that the lowest O/C ratio was obtained in the case of the most sophisticated of the three technologies. A rupee invested in Technology-3 produced gross output valued at Rs. 37.50 where as Technology-2 produced an output of Rs. 52.81 and Technology-1 Rs. 72. A very firm and unambiguous negative relation existed between capital intensity and output. It will be a paradox to assert that capital is more productive in the most primitive technology of non motorised craft than in the improved technology of large motorised craft. Pursuant to this, it appears that technological innovations result in the reduction of productivity of capital. However, this is a phenomenon to be explored in detail for arriving at a definite conclusion.

Looking at labour productivity, where the capital is more productive, labour seems to be least productive. Of the three technologies, labour is least productive in Technology-1 at Rs 125. Labour is more productive in Technology-2 and 3 than in Technology-1 (Table 7).

The role of the differences in technology contributing to factor productivity deserves a mention at this stage. Motorisation generally has immensely contributed to the extensive spread of fishing operations in the study area. The fishing crafts will have to

Table 7. Factor Productivity across the three technologies

Unit	Capital Investment (Rs. lakhs)	Labour Units	Average Revenue (Rs.)	Returns to investment (%)	Output-labour ratio	Output-capital ratio
Non motorised craft	0.15	2	272.27	54	125.66	72.61
Small motorised craft (<12m)	1.30	5	2270.88	61	440.95	52.81
Large motorised craft (>12m)	3.20	23	4986.80	34	216.82	37.49

concentrate on a limited area of operation cutting into each other's revenue and thereby drastically reducing the productivity of both labour and capital. Therefore, it appears that the greatest contribution of technology is to widen the area of operation of fishing. Motorisation of large craft has enhanced the reach of traditional fisheries 30-40 Km along the coast. It has also enabled the traditional craft to exploit the available resources timely and fully. Its operational days increased during monsoon seasons and drastically fell during lean periods due to the cash component in the operational cost. The loss of fishing trips during lean periods was more than compensated by gain in fishing trips during monsoon. The finding that capital is least productive in Technology-3 highlights the problem connected with suo motu adoption. The three components of capital viz. craft, engine and net employed in the larger crafts are not the results of scientific studies on the optimum combination of these components. There are crafts of comparable size with comparable onboard weight differing in the number of engines fitted to them. There are crafts with two engines and also with four engines. Each additional engine adds to the capital cost Rs. 40000-50000 without a corresponding contribution to productivity (Annamalai, 1995). This approach to investment alone can affect the productivity of capital adversely in Technology-3.

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