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FEBRUARY 1991

NATIONAL SYMPOSIUM ON RESEARCH AND DEVELOPMENT IN MARINE FISHERIES

MANDAPAM CAMP

16-18 September 1987

Papers Presented
Sessions V, VI & VII

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
(Indian Council of Agricultural Research)
P. B. No. 2704, E. R. G. Road, Cochin-682 031, India

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STRATEGIES FOR MARINE FISHERIES DEVELOPMENT IN INDIA

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ABSTRACT

Four decades of planned development of marine fisheries in India has raised the production level from about 0.5 to 1.6 million tonnes per annum. This growth in tonnage is not commensurate with the effort that has been expended over the period in terms of planning, research and development. Stagnation in production has been witnessed during the last decade. The deep-sea fishing programme is yet to yield any tangible result by way of a quantum jump in production, and its contribution has been marginal, not able to influence the overall production trend. However, marked changes have taken place in the pattern of exploitation and resources during the span of 40 years.

The paper analyses the cause and effect of some of the important aspects of marine fishery development in the maritime States and Union Territories. Resource research at various periods of time has come out with tentative recommendations on strategies that may be adopted in development of particular fisheries. These have, willy nilly, not been given a try, perhaps due to several constraints. Taking into consideration the present scenario of research and development, strategy options are indicated for management and development of the marine fisheries of the country.

INTRODUCTION

India has gone through 40 years of fisheries development. Marine fish production has increased from 0.5 million tonnes in 1950 to 1.6 million tonnes now. Thanks to the bilateral assistance received in the early stages and the business acumen of small entrepreneurs, the coastal trawl fishery has reached almost its zenith, with the support of the Government. The purse-seiners and more recently, the process of motorisation, have changed the character of the fishery. Further bilateral and international assistance and the national development with institutions and infrastructure have made India strong in many areas of fisheries management and development. The E.E.Z. has added a new dimension of opportunities and challenges. In the export front country has done very well.

Despite all these developments, the marine fish production has stagnated during the last decade and the overall growth rate has shown a declining trend. The time is ripe now to have an introspection of our past programme and their achievements and evaluate the present opportunities to increase production. These aspects are discussed in the paper and strategy options for management and development of marine fisheries are indicated.

TRENDS IN ALL INDIA MARINE FISH PRODUCTION

The marine fish production of India, since it began to be estimated in 1950 by the Central Marine Fisheries Research Institute has shown its growth as given below:

Period	Average Annual production (t)	Growth rate over the Previous period (%)
1951-55	565,543	-
1956-60	762,911	34.90
1961-65	735,131	3.64
1966-70	943,209	28.71
1971-75	1,200,434	27.27
1976-80	1,330,892	10.87
1981-85	1,502,592	12.90

After an initial spurt of growth of about 7% per annum during 1956-60, production came down during 1961-65 showing a slight reduction. Again it picked up during 1966-70 with a growth rate of

5.74% per annum. In 1970, production crossed the 1 million tonne mark. This period witnessed the consistently high landings of oil sardine with an all-time high of 301,641 t in 1968. During 1971-75, the growth rate was maintained at 5.45 % per annum. The next five years (1976-80) showed a poor growth rate of 2.17% per annum, as also the succeeding period (1981-85) with 2.58%. In fact, production fluctuated on a plateau from 1975 to 1982 between 1.25-1.42 million t. It was only in 1983, it crossed the 1.5 million t mark (1.546 million t). Production increased to 1.631 million t in 1984. After a slump in 1985 with 1.535 million t, it has reached about 1.693 million t in 1986, an all-time high so far.

A comparison of group-wise landings for the more important species based on average annual production during 1979, 1980 and 1981 and that during 1982-83, 1983-84, 1984-85 (because of shift to financial year) has been made in Table 1. The two periods represent the pre-1.5 million t and post-1.5 million t production per annum and the table has been prepared to find out the resources which had shown gains and losses. It is seen from the Table 1 that most of the groups had shown gains as follows: anchovies (54,321), perches (24,400 t), carangids (20,926 t) penaeid prawns (18,463 t), oil sardine (18,834 t), elasmobranchs (15,726 t), sciaenids (11,450 t), silverbellies (10,312 t), catfish (8514 t), pomfrets (8488 t) and lesser sardines (2392 t). Those which had shown losses were mackerel (25,521 t), bombay duck (16176 t), ribbonfish (12,068 t) and non-penaeid prawns (1118 t). The three groups, anchovies, perches and carangids together accounted for 50% of the total gain of the period. These groups, along with catfish have the potential for further development. Among those which have shown loss, ribbonfish will have future scope for exploitation.

Table 2 provides an overview of the trends in different sectors, pertaining to the above period for the years the effort data are readily available. For this exercise, all fishing units fitted with inboard or out-board engines/motors for propulsion such as crafts operating gill nets, dol nets, hook & lines and bag nets, have been grouped together under category "Mechanised, others". The other three categories are distinct.

At the all-India level, the effort of small mechanised trawlers showed an increasing trend from 1284×10^3 unit operations in 1981 to 1631×10^3 units in 1983-84, but declined to 1467×10^3 units in 1984-85. However the landings have shown an increase throughout the period even in 1984-85. The catch rates also showed a steady increase from 300 kg/unit in 1981 to 378 kg/unit in 1984-85.

The effort of purse-seiners showed almost a two-fold increase in 1982-83 from 37,883 units of operation in 1981 to 71,048 units in 1982-83. There after, the effort decreased to 53,272 units in 1983-84, but picked up to 62,430 units in 1984-85. The quantum jump in effort in 1982-83, led to fall in production from, 1,13,147 t in 1981 to 81,952 t in 1982-83. In 1983-84, with a reduction in effort, the catch was almost at the level of 1982-83. The catch increased to 100,000 t in 1984-85 with a rise in effort. The catch rate which was 2987 kg per trip in 1981, was drastically reduced to 1153 kg in 1982-83, but picked up to reach 1616 kg in 1984-85.

The craft using motorised propulsion showed an increasing trend in effort during the period, doubling from 830×10^3 units of operation in 1981 to 1621×10^3 units in 1984-85. However, the landings did not show a corresponding increase. In fact, there was progressive reduction of landings during the two years following 1981, but showed a sudden spurt from 2.93 lakh t in 1983-84 to 4.89 lakh t in 1984-85. The catch rates showed a declining trend in this sector from 410 kg in 1981 to 266 kg in 1983-84 only to rise marginally to 302 kg in 1984-85.

Relatively, the effort, landings and catch rates were stable with slight fluctuations during the entire period for the non-mechanised sector. The effort ranged from 9877×10^3 units; landings from 4,58,870 t to 6,56,928 t and catch rates from 45 kg to 56 kg.

Thus the all-India picture showed a slow but steady increasing trend in the small mechanised trawler sector, a declining trend in the purse-seine sector, an unsettled trend in the mechanised propulsions craft sector and a stable trend with some fluctuations in the non-mechanised sector.

PRODUCTION AND POTENTIAL IN THE STATES

Gujarat

The annual average marine fish production during the decade 1975-84 was 2.21 lakh t, with a range from 1.71 lakh t in 1970 to 2.51 lakh t in 1984.

The fishing crafts consisted of 2894 mechanised boats and 4100 non-mechanised crafts.

Table 1. *Gains/losses in Landings of major groups of fishes during the periods 1979-81 and 1982-83 - 1984-85*

Groups	Production (t) Average of 1979-81	Production (t) Average of 1982-83 to 1984-85	Gain/loss (t)
Elasmobranchs	47,939	63,665	15,726
Catfish	50,651	59,165	8,514
Oil sardine	1,63,580	1,82,414	18,834
Lesser sardine	65,795	68,187	2,392
Anchovies	54,882	1,09,203	54,321
Bombay duck	1,19,779	1,03,603	- 16,1760
Perches	35,174	59,574	24,400
Sciaenids	88,355	99,805	11,450
Ribbonfish	58,536	46,468	- 12,068
Carangids	30,184	51,110	20,926
Silverbellies	59,705	70,017	10,312
Pomfrets	42,464	50,950	8,448
Mackerel	58,484	32,963	- 25,521
Penaeid prawns	1,03,080	1,21,543,	18,463
Non-penaeid prawns	61,349	60,230	- 1,119

Table 2. *Trend of effort, catch and CPUE at all-India level*

Description	1981	1982-83	1983-84	1984-85
1. Mechanised trawlers				
a) Landings (t)	3,85,571	5,26,046	5,43,346	5,53,802
b) Effort, x 10^3 units	1,284	1,660	1,631	1,467
c) CPUE (kg)	300	317	33	378
2. Purse Seine				
a) Landings (t)	1,13,147	81,952	75,179	1,00,880
b) Effort, x 10^3	37,883	71,048	53,272	62,430
c) CPUE (kg)	2,987	1,153	1,411	1,616
3. Mechanised, others				
a) Landings (t)	3,40,550	3,12,359	2,92,754	4,88,735
b) Effort, x 10^3 units	830	798	1,100	1,621
c) CPUE (kg)	410	391	266	302
4. Non-mechanised crafts				
a) Landings (t)	5,34,007	5,16,760	6,56,928	4,58,870
b) Effort, x 10^3 units	9,877	10,904	11,706	10,141
c) CPUE (kg)	54	47	56	45

Of the former, 1410 were trawlers, 1225 were gill netters, 241 were dol netters and 18 were other types.

The major resources are Bombay duck (33% of average landings), croakers (16%) penaeid prawns (5.3%), elasmobranchs (5.8%), pomfrets (8.2% in 1981), *Lactarius* (5.4% in 1983), non-penaeid prawns (2.3%), ribbonfish (4%) and catfish (6.1% in 1982).

The contribution of mechanised boats in the total landings of the State increased to 60% in the 1970s and reached 82% in 1984. The trawlers contribute to 55% of the catch of all mechanised boats, the drift/gill nets to 26% and the dol nets to 18%.

Using the Maximum Contribution Approach, the potential yield has been estimated as 3.3 lakh t. Maximum production already obtained was 2.5 lakh t in 1984 and, hence, a net addition of 0.8 lakh t appears possible. It has been suggested that there is scope to add additional about 300 drift/set gill netters in South Gujarat and Jamnagar coast, 380 trawlers in Kutch and Jamnagar coast, and about 100 dol netters in Saurashtra region to exploit the additional marine fisheries potential of the State, all in a phased manner (Balan, *et al.*, 1987).

Maharashtra

The average annual production was 2.73 lakh t, with a minimum of 2.32 lakh t in 1980 and a maximum of 3.06 lakh t in 1984. The pelagics contributed to 39.3% and the demersals to 60.7%.

The fishing crafts included 4557 mechanised boats, 46% of them bag netters, 29% trawlers and 25% gill netters. Non-mechanised crafts were about 7925 in numbers.

The major resources are Bombay-duck (range of production 45,162 t in 1982 - 82,136 t in 1981), non-penaeid prawns (32, 130 t in 1983 - 69,010 t in 1975), penaeid prawn (21,720 t in 1981 - 45,640 t in 1979), croakers (13,960 t in 1980 - 22,590 t in 1984), pomfrets (8,350 t in 1975 - 25,520 t in 1983) and catfish (8,240 t in 1975 - 13,420 t in 1984).

During the period of 1975-84 under review, research findings showed that Bombay-duck fishery fluctuated; non-penaeid resources showed decreasing trend; penaeids showed no discernible trend; croakers recorded increasing trend since 1980; pomfrets catch was about stable and catfish showed an increasing trend. The dol net catch showed an inverse relationship with effort expended. It has also been seen that landings by mechanised boats increased from 147,900 t (57.6%) in 1975 to 286,900 t (93.6%) in 1984. Non-mechanised landings were almost vanishing with only 6.4% contribution (19,400 t) by 1984 in the State's marine fish catch.

The potential yield, as calculated from the Maximum Contribution Approach, is 3.70 lakh t. Since a maximum catch of 3.10 lakh t has already been obtained, the net additional yield would be 0.6 lakh t. It has been estimated that 40% increase in the effort of trawlers and 50% increase in the effort of gillnetters, in phased manner, would be able to achieve the additional production. Raigad and Ratnagiri districts may come for special efforts for providing infrastructural facilities and increase in fishing units as suggested above (Srinath *et al.*,1987).

Goa

During the period 1975-84 the marine fish production in Goa varied between the minimum of 24,500 t in 1980 and maximum of 38,500 t in 1984, with an average of 33,800 t during the period 1980-84.

The mechanised fishing fleet consisted of 494 trawlers 274 gillnetters, 66 purse seiners and 74 others. The non-mechanised crafts were 2066 in number. The mechanised landings increased from 41.4% in 1975 to 89.3% in 1984. The trawler landings dominated with 68% followed by purse seiners (27%) and others (5%).

The annual average pelagic landings during 1975-84 were 16,330 t. Their contribution to total landings showed a decreasing trend from 71.1% in 1975 to 33.2% in 1983. The demersal average landings were 14,710 t. There was progressive increase in their contribution from 28.9% in 1975 to 66.8% in 1983. Among the pelagics, oil sardine dominated the landings during 1980-84 with an average annual contribution of 31%, followed by mackerel (16%) other sardines (11%) and carangids (9%). Among the demersals, penaeid prawns constituted 21%, stomatopods 11%, sciaenids 8% and catfish 8%.

The marine fisheries potential for Goa in the Inshore waters has been calculated to be about 54,000 t (Kurup *et al.*, 1987). It has been suggested by the above authors that there does not seem to be any scope for increasing the effort of purse seines and gillnetters. However, in the case of trawlers, about 100 boats can be additionally introduced in a phased manner with periodic monitoring of their impact.

Karnataka

During 1975-84, marine fish production varied form 87,000 t (1975) to 1,55,000 t (1982) with an annual average of 1,22,127 t. The landings were characterised by wide fluctuations and the magnitude was determined by oil sardine and mackerel production.

The fishing crafts included about 2000 mechanised boats with about 1500 trawlers, 300 purse-seiners and 29 gill netters, and about 6900 non-mechanised crafts. The mechanised boats contributed to 85.9% of production.

The pelagics accounted for 69.1% of the total marine fish production of the State and demersals for 30.9% . Oil sardine, mackerel and whitebait together contributed to more than 50% of the total landings. The percentage contribution of pelagics showed difference between the five-year periods of 1975-79 and 1980-84, which, respectively, were as follows: lesser sardines 2.0% and 5.3%; white bait 0.5% and 10.1%; ribbon fish 0.6% and 4.2%; carangids 1.0% and 5.0%; seerfish 1.6% and 4.4% and tunas 0.9% and 1.9% among those which showed increased contributions: mackerel 34.6% and 13.0% among those which showed decreased contributions: and oil sardine 46.7% and 48.4% which did not show much variation.

The contribution of demersal group to the total landings varied from 18.9% in 1975 to 46.4% in 1983. Catfish, silverbellies, sciaenids and penaeid prawns were the dominant groups. The percentage contributions of the different groups in the demersal landings during the five-year periods 1975-79 and 1980-84 were respectively - elamosbranchs 9.2% and 8.6%; catfish 21.1% and 16.7%; sciaenids 9.1% and 6.9%; silver bellies 10.6% and 9.4%; pomfrets 2.6% and 3.8%; pernaeid prawns 18.4% and 13.8% and others 29.0% and 40.8%.

The contribution of mechanised and non-mechanised boats to the total landings was 11.2% and 88.8% respectively in 1975. In 1977, the proportion suddenly changed to 57.5% and 42.5%. In 1984, the proportion was 89.6% and 10.4%, thereby showing that the non-mechanised sector has practically been eclipsed. In 1980, the mechanised landings were shared as 80.3% by purse-seines, 19.4% by trawlers and 0.3% by others. In 1984 the shares changed to 68.9%, 29.3% and 1.8% respectively.

In 1977, the year of introduction of purse-seines in Karnataka, the effort of purse seine operations was only 5000. In the following years the effort in number of operations was as follows: 1978- 19,000; 1979 - 26,000; 1980 - 20,000; 1981 - 31,000; 1982 - 55,000; 1983 - 39,000 and 1984 -45,000. The average CPUE for the period 1980-84 was as follows: 1980 - 3895 kg; 1981 - 3068 kg; 1982 - 1565 kg: 1983 - 1369 kg and 1984 - 1731 kg.

The maximum expected yield from the inshore waters has been calculated as 2.2 lakh tonnes (Kurup *et al.* 1987). The above authors, based on current information, have concluded that there does not seem to be any scope for increasing the fleet strength of purse seiners and small trawlers.

Kerala

Kerala accounts for about one-fourth of marine fish production of India. The average annual production in 1983 and 1984 has been 3.9 lakh t. The State produced the highest of 4.5 lakh t in 1973, after which there has been a steady decline reaching a low of 2.7 lakh t in 1981, picking up slowly thereafter. In general, production has been stagnant.

The fishing crafts in 1979-80 were 3038 small mechanised boats including 2630 trawlers, 362 gill netters, 37 purse seiners and 9 other categories. The purse seiners which were introduced in 1979 reached a number of about 70 in 1982 and has remained at that level since then. The most significant development has been the motorisation (outboard) of the country crafts which started in 1982, the number of which has reached about 4000 by 1984 and 6000 now. This is one of the fastest development programmes in the country. The non-mechanised crafts were about 26,000 in number.

Prior to 1980, the artisanal sector contributed over two-thirds of marine fish production in the State. By 1983, the change over took place and, in 1984, the mechanised sector (including the motorised canoes) took the two- thirds share of production. The motorisation with outboard engines gave a sudden fillip in production by this sector, though not increasing in any way the net production of the State. Prior to motorisation, the boat seines had a share of 22,400 t in 1981. On account of their greater mobility due to motorisation, their share went up to 1,11,900 t (29% of the State's marine fish production) in 1984. Similarly, the gill netters increased their catch from 470 t to 12,900 t in the same period. The share of purse-seines has remained at an

average of 16,000 t, accounting only for 5% of the State's production during 1980-1984, without showing any trend.

The annual pelagic fish landings (average of 1983 and 84) were 2.64 lakh t (68%) as compared to the demersal fish landings of 1.26 lakh t (32%). Taking the average of 1977 and 78, prior to introduction of purse-seines or motorisation of boat seines both of which are for pelagic species, the percentage composition of pelagics remained at 67.5% (2.42 lakh t)and demersals at 32.5% (1.17 lakh t), thereby clearly indicating that the modernisation of the craft/gear with respect to the pelagics, did not result in any deviation in the percentage contribution of these two groups. It has also shown that, in the given situation, the availability of resources has controlled production rather than the catchability of the craft/gear. Oil sardine, the mainstay of Kerala production has shown the fluctuations typical of the species. The 1983 and 84 average was 1.5 lakh t (38% of States's production). The same species had a share of 2.5 lakh t in 1968. It went down to an all-time low of 70,000 t in 1980. It has stabilised around 1.5 lakh t subsequently. The Indian mackerel production was 12,200 t (average of 1983 and 84). The species had a share of 1.0 lakh t in 1971. But the magnitude has come down considerably in the subsequent period. The penaeid prawns, the economic mainstay of the fishery, contributed to 32,600 t (average 1983 and 84), whereas it had a share of 84,770 t in 1973. In the recent years, it had shown fluctuations, but generally in the lower order of production. The whitebait with an average of 48,000 t in 1983 and 84 has generally remained steady about this level. Catfish production has fluctuated over 3 decades; having reached 33,500 t in 1974, it fluctuated around 11,000 t in the recent times. Coastal tuna production has been stable around 6000 t, although a maximum of 15,400 t was taken in 1979.

The CPUE of small trawlers came down from 325 kg/trip during 1975-79 to 240 kg/trip during 1980-84. The CPUE for the prawn components showed a similar decrease from 180 kg/trip to 85 kg/trip for the same period. The purse seiners' CPUE came down from 3110 kg/trip in 1980 to 1300 kg/trip in 1982, although it picked up to 2900 kg/trip in 1984.

The maximum catch prospects for the State in the presently exploited waters, has been estimated at about 4.8 lakh t (Jacob *et al.*, 1987). Considering the present level of production, production means, catch trend and economics, the suggestion made is not to add any more trawlers or purse seiners, but to add about 210 gillnetters with in-board engine in a phased manner. Since motorisation is recent, and its impact is yet to be critically evaluated, any increase in their number should wait further appraisal (Jacob *et al.*, 1987).

Tamil Nadu

The average annual marine fish production during 1975-84 has been 2.32 lakh t accounting for 16.7% of all-India production. The minimum during the decade was 2.06 lakh t in 1977 and the maximum was 2.81 lakh t in 1983.

The fishing crafts included 2757 mechanised boats, of which 2,614 were trawlers and 143 gillnetters, and 43,343 non-mechanised crafts. During 1975-84, the mechanised boats contributed an annual average of 94,148 t (41%) and the non-mechanised crafts the rest. The contribution of non-mechanised crafts which was 68.5% during 1975-79, came down to 51.48% during 1980-84. In 1982, the mechanised boats landed 1,27,742 t as against the 1,18,419 t by non-mechanised crafts. Of the mechanised catches, the six major centres Pudumanikuppam, Cuddalore, Nagapattinam, Mandapam, Rameswaram and Tuticorin together contributed to an average of 56,402 t during 1980-84. The balance between the two sectors has been delicate.

The demersal catches contributed to 54.6% with average landings of 1,26,528 t, compared to the pelagic landings of 1,05,350 t during 1975-84. In the traditional fisheries, silverbellies, with an average catch of 38,492 t, showed an increasing trend. Sardines (other than oil sardine) (average 28,240 t) showed an increasing trend from 1976 to 1984. Anchovies (16,192 t) showed a decreaing trend from 1975 to 1979 and an increasing trend thereafter. Elasmobranches (15,980 t) showed an increasing trend from 1982. Croakers (14,815 t) showed a decreasing trend from 1981. Ribbonfishes (13,022 t) continued with a decreasing trend since 1975. Penaeid prawns (11,741 t) showed an increasing trend from 1975 onwards. Crabs (10,359 t) showed an increasing trend after 1981. Carangids (9,729 t) showed an increasing trend during the decade. Perches (8,838 t) exhibited an increasing trend during 1978-84.

Analysing the trawler landings at some of the centres, the effective rate of increase per unit effort was found to be 0.73% at Rameswaram, 1.09% at Tuticorin, 3.87% at Pudumanikuppam,

1.23%at Mandapam and 1.5% at Cuddalore (Dharmaraja *et al.*, 1987). Scope for increasing catches further was seen only at Pundumanikuppam among the above centres.

By the Maximum Contribution Approach, the potential yield in the 0-50 m depth zone has been calculated at 3.25 lakh t (Dharmaraja *et al.*, 1987). Considering the average landings of 1982-84 at 2.60 lakh t, the additional potential is estimated to be 65,000 t. The share of the mechanised sector would be 35,000 t and that of the non-mechanised sector 30,000 t. Working on the present catch rates of trawlers at 250 kg/unit, the number of trawlers that can be additionally introduced is estimated at 560, which may be done in a phased manner. It has also been suggested that the mobility of the non-mechanised crafts may be increased by motorisation (Dharmaraja *et al.*, 1987).

Pondicherry

The average annual production during 1975-84 period was 10,340 t, with the maximum of 14,940 t in 1984 and minimum of 6,500 t in 1977. During 1983-84 period, the average production was 14,800 t.

The fishing crafts included 176 mechanised and 1750 non-mechanised crafts. The annual contribution of mechanised boats was 3,150 t (30.5%) and the rest (7,200 t at 69.5%) was from the non-mechanised crafts. The CPUE of mechanised boats which remained between 82-161 kg during 1975-79, steadily increased to 139 kg/trawler-day in 1984. About 91.1% of total mechanised catch was from trawlers, and the rest from gill netters.

The pelagics contributed annually to 6188 t and the demersals to 4155 t. The major groups, in their order of abundance, were other sardines, carangids, anchovies, perches, mackerel, silverbellies, crabs, croakers, penaeid prawns, flying fish and elasmobranchs.

The estimates of potential yield in the inshore waters were 19,000 t by Relative Response Model and 21,000 t by Maximum Contribution Approach (Dharmaraja *et al.*, 1987). Taking the mean of the two estimates (20,000 t), the additional catch expected is 5,200 t, of which the share of mechanised sector would be 1,800 t and that of the non-machanised sector 3,400 t. The existing trawlers as well as non-mechanised crafts can take the additional catch, in view of the recent increase in their catch rates. Motorisation of non-mechanised units has been suggested (Dharmaraja *et al.*, 1987).

Andhra Pradesh

Average annual marine fish production during 1975-84 has been 1.21 lakh t, with the minimum of 82,000 t in 1978 and maximum of 1,56,000 t in 1975.

The fishing units included 580 small trawlers and 36,000 non-mechanised crafts. During 1977-84 period the non-mechanised sector was dominant accounting for 74.36% of the State's marine fish production. During 1980-84, major contribution came from drift/gill nets(45%), followed by small trawlers (25%), shoreseines (13%), boat seines (12%) and others (5%). The pelagics contributed 53% of production and the demersals 47%. Data show that years with good landings of pelagics, particularly lesser sardines, have shown higher overall marine fish production in the State, implying the sway this group holds over the demersals.

The cleupeoids dominated the landings with 30% contribution. Ribbonfish (8%), croakers (8%), penaeid prawn (7%), elasmobranchs (6%), silverbellies (5%), perches (4%), catfish (4%), pomfrets (3%), mackerel (3%) and non-penaeid prawns (3%) were the other important groups in the fishery. The landings of penaeid prawns ranges from 5700 t in 1980 to 10,600 t in 1983 indicating no regular trend.

Besides the small trawlers, large trawlers (23 m and above), numbering about 70 were operating off Andhra coast from Visakhapatnam fisheries harbour. Catch and other details from these vessels were not available to the CMFRI. (Effort has been made very recently to get these data which are under analysis). For the mechanised boats, the CPUE ranges from 202 kg in 1980 to 384 kg in 1983, with an average of 284 kg during a period I980-84. No clear cut trend between effort expended and quantities landed was evident. Similar was the case with the traditionl sector.

In Visakhapatnam fisheries harbour, an average 130 small trawlers operated daily, during 1980-84, and the average CPUE was 220 kg. Penaeid prawns (10-15%), perches (17-28%), threadfin breams, croakers, carangids and lizard fishes constituted the important groups. In Kakinada fisheries harbour, the average number of trawlers operated was 160 and the average CPUE was 330kg. Penaeid prawn contribution (12-25%) was higher than at Visakhapatnam.

The potential yield in the 0-50 m depth has

been estimated at 2,03,000 t by the Maximum Contribution Approach (Alagaraja *et al.*, 1987). Considering the fact that a maximum of 1,56,000 t has been taken in 1975, the net additional potential is estimated at 50,000t. It has been suggested that in the first place, the average production level should be raised to 1,50,000 t. Of the additional 50,000 t, efforts may be made to harvest 25,000 t initially. The additional crafts required to achieve this, based on present catch rates, would be 1705 drift/gill netters, 87 small trawlers, 105 shore seine units, 370 boat seine units and 312 other types. In the next phase, the effort may be increased similarly to get the still remaining 25,000 t of the potential. Thus, by 2000 A.D., the presently estimated potential of 2,00,000 t may be fully harvested (Alagaraja *et al.*, 1987).

Orissa

The average annual production during 1975-84 was 34,027 t, with the maximum of 46,773 t in 1984 and minimum of 15,072 t in 1977.

The fishing crafts included 745 mechanised boats, of which 470 were trawlers and 275 gill netters, and 10,550 non-mechanised crafts. The contribution of mechanised sector to the fish production was 21,126 t (53%). The catch rate of trawlers has shown a consistent increase from 63 kg in 1980 to 358 kg in 1984.

The pelagics contributed to 15,993 t and the demersals to 18,034 t. The major groups are pomfrets (15%), croakers (13%) *Hilsa* (12%), catfish (9%), and prawns (4%). Exploratory survey indicated the occurrence of mackerel upto the 100-m contour line off the coast.

The potential yield, as derived from the Maximum Contribution Approach, is 75,500 t (Scariah *et al.*, 1987). Considering much higher estimates made by earlier studies, the potential yield is taken as 1,00,000 t. Net additional potential yield is calculated a 54,000 t. At the present level of catch rates, additional fishing units that can be introduced over the next 5 years are estimated at 160 numbers of trawlers, 140 gill netters and 1700 non-mechanised crafts (Scariah *et al.*, 1987).

West Bengal

The 1975-84 average annual production was 19,840 t, with the maximum of 39,910 t in 1984.

The fishing and supporting crafts included 1054 mechanised boats, of which 767 were gill netters and 287 were carrier boats, and 41,000 non-mechanised crafts. The mechanised boats contributed 53% of the State's marine fish production and the non-mechanised crafts 47%. The mechanised bag-net unit showed a CPUE of 613 kg, *'Jangal-Jal'* 265 kg and gill net 200 kg. The CPUE of non-mechanised crafts averaged 138 kg.

The pelagics formed 43% of the catches and the demersals 57%. The major species were non-penaeid prawns (10.6%), catfish (10.3%), pomfrets (9.8%), Bombay-duck (4.8%), penaeid prawns (4.6%) and *Hilsa* (4.8%).

The Maximum Contribution Approach showed the potential yield as 60,000 t (Philipose *et al.*, 1987). The net additional yield would be about 20,000 t. The additional crafts that could be introduced include 60 gillnet units, 10 bag-net units and *'Jangal-jal'* units among the mechanised boats and 150 non-mechanised craft (Philipose *et al.*, 1987).

STRATEGIES FOR DEVELOPMENT AND MANAGEMENT

Development objectives

The character of marine fishery resources of India, the geographical spread of the subcontinent, and the socio-economic and political system involved in the management and development of the fisheries are too complex for evolving a national policy which can be straight away implemented through plans and subsequently evaluated. The framers of our Constitution gave the responsibility of fisheries development to the States. The Center has a promotional role allocating resources to various schemes developed by the States as also sponsoring schemes. In the present context of EEZ, the development programmes outside the territorial waters of the States are managed by the Center. Thus even where a National Fisheries Policy has been evolved, the responsibility for implementation of the plans is divided among several agencies, and naturally the ex-post evaluation, if done, is within these agencies, and does not necessarily link up with the objectives of the National Policy. The objectives themselves may be too many such as to provide protein for the people, to provide employment, to uplift the socio-economic conditions of fishermen, to increase GNP and to increase foreign exchange earnings and, if taken together, might necessitate shifting of strategies too frequently resulting in unfulfilment in all the objectives.

Evolution of fishery sectors

India's marine fisheries which was singularly artisanal in the eighties and today we have the following five of them in commercial fisheries:

1. artisanal crafts
2. motorised crafts
3. coastal trawlers
4. purse seiners
5. deep-sea trawlers

The artisanal sector has been at the losing end with the emergence of the coastal trawlers. Its dominance in fish production has been irreversibly lost with the introduction of the motorised crafts, with in-board or out-board engines. The entry of purse-seiners, particularly in Karnataka, almost eclipsed the artisanal sector in the State. With all these advancements, the total marine fish production remained more or less level for about 10 years, thereby proving that the changes led only to sharing of resources now in a different proportion in the present fishing grounds and not to any sizable net increase in production. It also proved that the new investments made during the period did not result in additional production.

Marine Fishing Regulation Acts

Sharing of the resources as above, that is cutting into the economics of the weaker sector, did lead to conflicts resulting in violence, carnage and burning of boats. This led to enactment of regulations and framing of rules by the States delimiting zones for different sectors. Here again there has been no consensus among the different maritime States/Union Territories. While some did not feel the need of it, others enacted rules in haste leading to legal battles and yet others are considering the issue.

Subsequent to the Indian Fisheries Act of 1897, the Ministry of Agriculture Govt. of India enacted the Maritime Zones of India (Regulation of Fishing by Foreign Vessels) Act of 1981 and made the Rules of 1982 under the Act. As specified, the Act deals with fishing by foreign vessels under licence or charter in the EEZ outside the territorial water.

The Sates enacted Acts and framed Rules for regulating fishing in the territorial waters. Under Kerala Marine Fishing Regulation Act of 1980, the State regulated fishing activities under Rules framed in 1980 and subsequently. Fishing is prohibited for all fishing vessels fitted with mechanical means of propulsion, except motorised country crafts, upto 30 m depth in the area from Kollengode to Paravur and upto 20 m depth in the area from Paravur to Manjeswaram. Purse-seine is prohibited from operating within the territorial waters i.e. upto 12 n. miles from coast. The rules also ban the use of bottom trawl gears having less than 35 mm mesh in the specified area.

The Goa, Daman, Diu Marine Fishing Regulation Act was enacted in 1980. Under the rules, fishing with a mechanised boat is prohibited within 5 km from the coastline. The area upto 5 km is reserved for non-mechanised crafts and Rampan. The mesh regulation bans use of nets having less than 24 mm mesh for fish and less than 20 mm mesh for prawns.

The Maharashtra Marine Fishing Regulation Act of 1981 have rules, but for the present there are none on prohibition of fishing by any class of craft in any area. Similar is the case with the Karnataka Marine Fishing Regulation Act of 1986.

The rules made under the Tamil Nadu Marine Fishing Regulation Act of 1983 ban bottom trawling upto 3 n. miles from the coast. Within 3 n. miles non-mechanised boats can go for fishing with boat seines and hook & lines. The rules prohibit fishing within 100 m below a river mouth. The mesh regulation states that no gear less than 10 mm mesh, knot to knot, in respect of nets other than trawl nets shall be used. Although Pondicherry has not yet enacted an Act, mechanised boats are permitted to operate only at 7 fm depth and beyond between 6 A.M. and 6 P.M.

It is evident from the above that there has been no overall strategy for regulating fishing in the coastal waters and that the States have different approaches on the issue. The fish does not respect State boundaries in their migration. The resources are generally concentrated in the inshore waters. Fishermen of each sector is for economic gains from the common property resources. These are reasons for frequent violations of the rules, confiscation of boats and seeking judicial redress. More detailed discussions among fishery managers, scientists and the fishery sectors would be desirable before improving the rules under the Acts.

Management of coastal fisheries

Management of fisheries sector is beset with problems arising from the special characteristics of the resources. In the early stages of development of the fisheries, production has been in-

creasing steadily with effort as the growth rates up to mid seventies have indicated. Last 10 years, with the exception of recent two years, witnessed a depression in production against an escalation in effort, particularly in the coastal trawler sector. This is despite the purse seiners introduced into the scene and the sudden fillip in motorisation of country crafts.

The average annual growth rate fell sharply during this period as compared to the previous two decades. Today, the coastal trawler sector contributes to about 35% total marine fish production, the motorised crafts (drift/gill nets, bag nets, hook & lines etc.) to about 30%, the purse seiners to about 6% and the artisanal sector to about 29%.

The pelagics and demersals contribute equal share of about 50% each to the total marine fish production of the country. While the trawlers work on the demersal resources, the other gears work essentially on the pelagics; but since the operational depth of these gears is not much, part of demersal resources are caught in these gears too. The tropical pelagic shoaling fishes particularly oil sardine, lesser sardines, achovies and mackerel are known to be small in size and short-lived and they get into the fishery in their first year of life itself, and their contribution to fishery in the second year of life is much reduced. Studies so far have indicated that the fishery for these species is controlled more by fishery-independent factors than by fishery-dependent factors. Therefore, management of these fisheries would depend on a thorough knowledge of their distribution in their juvenile and spawning phases and distributing the effort by various sectors evenly so that the adult stocks are judiciously fished. Juveniles/young fish stocks cannot be exploited heavily both for reasons of future recruitment and economics of the fishery. This calls for sound knowledge on the resources and stocks on the research side and management decisions on distribution/allocation of effort by the different sectors with regulation of mesh size.

The erstwhile Pelagic Fisheries Project's studies have indicated the stock level of oil sardine at about 4.00 lakh t. Reviewing the oil sardine production of Kerala, Balan and Reghu (1979) concluded that the present level of pressure by the indigenous fishery will not have any adverse effect on the oil sardine stock.

The massive introduction of purse-seiners in Karnataka at one stroke in 1977, which was further augmented subsequently, has received attention of the scientists. This led to making several important recommendations on the management of purse-seine fishery. Jacob *et al.*, (1979), who studied the impact of purse-seiners on the Rampan fishery in the immediately following period, found that the Rampan units which were 75 in number in 1977 got reduced to 30 in 1979. The catch rate of Rampanies came down from 4.5 t/units operation in 1977 to 0.3 t/unit in 1979. Immediately about 1160 Rampan persons were thrown out of job. The above instance has been one of the major jolts in the fisheries sector in the recent times. The authors suggested enforcement areas of operation for purse-seiners and Rampans, as also to make plans to get more fishermen take to purse-siening.

More serious problems were encountered in the purse-seine fishery of Karnataka later. In 1979, the vessels landed unusually large catches of oil sardine in ripe-running condition. On timely observations on the above, the Central Marine Fisheries Research Institute brought the implications of such fishing on the spawning stocks and the Government of Karnataka appealed to the purse-seine fishermen to abstain from fishing during June-September period which coincided with the spawning period of oil sardine and mackerel (Silas *et al.*, 1980). Subsequently, during September-October 1980, the purse-seines were found catching large quantities of male catfish *Tachysurus tenuispinis* incubating eggs. At Mangalore, Malpe and Gangoli, the purse-seiners caught 528.4 t of adult catfish with 37.6 t of incubated eggs. Commenting on the wasteful and destructive fishing of purse-seines Silas *et al.*, (1980) made the following recommendations to manage the fishery.

(i) Identication and determination of the magnitude of specific resources,

(ii) Prevention of frequent shifting of base of operations of the the purse-seines,

(iii) introduction of mesh regulation and minimum legal size for capture,

(iv) delimitation of areas and period of operation for specific resources,

(v) control on annual/seasonal quota on catches, and

(vi) observance of closed seasons for purse-seines during the spawning period of pelagic fishes.

As the purse-seine effort was relentlessly in-

creased, the species compostion in the catches changed. Besides oil sardine, mackerel and catfish, anchovies, tuna (*Euthynnus affinis*, *Auxis thazard* and *A. rochei*), carangids, silverbellies, other clupeids, prawns, pomfrets and other miscellaneous fishes started appearing in the catches (Dhulkhed *et al.*, 1982). This led to advising the fishery managers of Karnataka to avoid heavy pressure on critical stages such as juveniles and spawning stocks of oil sardine, mackerel, catfish and horse-markerel. At this stage, the purse-seine operations had been prohibited from 1st June to 30th September. The vessels were operating in 20 m depth from September to January and 30-40 m from February onwards.

Heavy landings of whitebaits by purse-seines received further attention. The whitebait catch which was 73 t in 1978 in Mangalore increased to 721 t in 1979 and 4588 t in 1980. It came down to 2240 t in 1981 (Rao *et al.*,1982). The investigations pointed out that the mesh size of purse seines at 12-13 mm led to capture of very young fish of important pelagic species such as oil sardine, horse-mackerel and scad and warned that it was wasteful and would lead to decreased catches in future. The study recommended capture of whitebait which had completed one breeding cycle and was at the fag end of its life but advised redeployment of purse-seiners at all the major centres and building up of infrastructural facilities to avoid serious glut situations.

Against such a background of hasty strengthening of purse-seine fleet which exceeded 250 in numbers in a short time, Kerala made a cautious approach. The strength got itself restricted to about 60 units localised at Cochin. The impact study made by Jacob *et al.* (1982) found that at the present level of exploitation and availability, the effect of purse-seine fishery was not tangibly felt on the aritisanal fishery. The fluctuations in the catch of artisanal fishery during 1980-81 were attributed to decreased or greater availability of the stocks of oil sardine.

The few examples cited above on the management and development of the purse-seine fishery would vouchsafe for greater caution in managing the coastal fisheries.

Turning attention to the demersal resources, it is seen that the peaneid prawn fishery has been the prime concern of the fishery planners, managers and scientists. This is in view of the fact that this fishery has been the backbone of the Indian fishing industry in economic terms. The entire coastal trawler sector of the country is based on this resource and everything else caught is considered a bye-catch. During 1976-1985 period, the penaied prawn landings fluctuated between 83,540 t and 1,30,000 t, with an average of 1,12,460 t. The amplitude of fluctuations was greater in the major prawn-producing States of Kerala (average 34,884 t: variations plus 17,449 t and minus 12,616 t) and Maharastra (average 35,234 t; variation + 10,409 t and - 1,357 t) than in other States. Based on controlled breeding and domestication of many of the penaeid prawns, it has been proved that these prawns breed throughout the year. It has also been understood lately that prawns migrate long distances, for example from Cochin to Tirunelveli coast in Tamil Nadu, based on mark-recovery studies (Anon, 1982). It has generally been suggested that the prawn stocks are being fished about the optimum level, but in centres like Sakthikulngara, there are signs of economic overfishing, if not biological overfishing. George *et al.* (1980) felt that restriction on input of effort is the only probable approach to management. The mesh size of cod end of shrimp trawls has been progressively reduced at many centres. At Kakinada, the mesh which was 25 mm during 1967-70 was observed to have been reduced to 10-20 mm (82% less than 18 mm) in 1977 and further to 8-20 mm (85% less than 17 mm) in 1978. Rao *et al.* (1980) observed that, consequent to reduction in mesh size, there was variation in production of penaeid prawns: species composition changed and *Acetes* spp.entered the fishery for the first time; and size of prawns came down as exemplified by capture of *Metapenaeus dobsoni* less than 60 mm and *M. monoceros* in 81-90 mm range in relatively high proportion. It is now learnt that the trawlers have started increasing the mesh size having realised the above problems.

New knowledge on certain prawn resources has emerged in the recent times. Although, trawling at night is reportedly prohibited in Sakthikulangara, some trawlers operating in the night caught adults of *Penaeus canaliculatus*, 150-200 mm in length, at 19.6 kg/boat (Suseelan *et al.*, 1982). This species is never caught in day trawling and, therefore, will be lost to the fishery if night trawling is prohibited. Traditional fishermen resist night fishing. Thus it becomes a socio-economic problem for proper management and a development problem for utilisation of this

high value resource. Off Bombay waters, the occurrence of another high value prawn, the Kuruma prawn *Penaeus japonicus*, was high-lighted (Aravindakshan and Karbhari, 1982). At Sassoon Docks, the species is landed at 10-15 t per annum. Similarly occurrence of new prawn resources of *Metapenaeus stridulans, Parapenaeus longipes, Trachypenaeus curvirostris* and *Solenocera choprai* along Maharashtra coast was reported (Aravindakshan and Karbhari, 1983). A potential new resource of *Metapenaeus moyebi* in the estuarine fishery of Karnataka was brought to light (Sukumaran and Nandakumar, 1983). Such new scientific information should receive immediate attention for guiding the development of fisheries, especially for high value resource.

Diversification of the fishery has been very often advocated by every scientific forum but very little has been done in this direction. The resources available for diversification have been indicated. These are the anchovies, horse-mackerel, catfish, threadfin-breams, ribbonfish, sciaenids and perches which have further potential for exploitation in several States. Economic returns in such ventures will not be as good as in shrimp fishery for obvious reasons and this acts as a disincentive for diversification. Proper incentives for the fishery which would concentrate exclusively on such identified resources should be thought of as a new development strategy in order to reduce the heavy pressure on shrimps and obtain higher landings of other groups for overall increase in production. Since the resources are high in magnitude, investment on additional infrastructure required and post-harvest handling, processing and marketing may not be shied away. If the national policy is to provide additional fish protein to the people, diversification of fishing, away from shrimp, cannot be further postponed.

Deep-sea fishing

When Government of India established the Deep-Sea Fishing Station in 1946, the concept of deep sea fishing was perhaps narrow, to include areas adjacent to the area of operation of the artisanal sector. The survey vessels then were just adequate for that coverage. In 1970, with the addition of the new class of 17.5 m, trawlers, it was presumed that India was venturing into deep sea fishing. The Symposium on Development of Deep Sea Fishing organised that year discussed elaborately plans for deep sea fishjing (*vide* Proc. symp. Devl. Deep-Sea fishing, CIFO, Cochin, 1970). In the V and VI plan periods several new survey vessels for covering the Exclusive Economic Zone were added. Large Mexican-type trawlers (23-26 m OAL) were introduced by the private sector and, after going through ups and downs, this sector has now stabilised with 70-100 vessels at a single port at Visakhapatnam. Their operational range generally overlaps with the traditional sector as also the coastal trawlers, occassionally extending beyond. Analysis of fishing data of some of the vessels recently made available showed that the catch rates for prawns (headless weight) ranged from 16.3 kg to 20.1 kg per hour of trawling. With about 110 trawlers operating in the area upto Sandheads, the situation is near saturation.

Deep sea fishing is capital intensive and risk prone. The species resources are varied with a higher volume of low value shrimp/cuttlefish/fish. Since the tendency is to conserve fish hold space for the high-value-low-volume groups, much of the catch of the voyages is thrown overboard. Unless post-harvest technology develops in future to give added value to the deep sea resources, such wastage of non-conventional resources would continue to occur.

For a long time, it was the policy of 'go it alone' with regard to deep sea fishing. The enactment of Maritime Zones of India (Regulation of Fishing by Foregin Vessels) Act of 1981 provided for foreign collaboration under charter and licence in the fishery sector. Experience had shown that this did not provide the expected advantage to India in terms of resources data, manpower development and entrepreneurship. During a span of less than five years several thousand tonnes of fish had been caught by the chartered vessels and landed in foreign ports, and three to four times that quantity comprising uneconomic varieties had been caught and destroyed. Now a new policy of joint venture is in force and is yet to pick up momentum. The joint venture should be an intermediate step towards national development of deep sea fishing. The medium-term and long-term objectives should be kept in view rather than short-term gains. Appropriate monitoring, control and surveillance (MCS) system with necessary legal, operative and administratives structure should be introduced to oversee the performance of joint venture projects. As in the case of charter vessels, there will be wastage of resources by discarding the bye-catches, but this has to be avoided at any cost as such quanti-

ties of fish may be used for meeting the nutritional needs of the Indian people.

The Exclusive Economic Zone

The declaration of the Exculsive Economic Zone of India in 1977, under the UNCLOS treaty, has given us sovereign rights to explore, exploit, conserve and manage the living resources, besides the non-living resources over an area of about 2 million sq. km. This provides an opportunity as well as challenges and obligations to utilise the resources judiciously.

The potential fishery resources of the EEZ have been estimated as 4.5 million t by George *et al.* (1977) after shifting all the earlier estimates made by national and international agencies/scientists and the exploratory fishery survey data available at that time. Subsequently large amount of survey data has been generated through the operation of large survey and training vessels. The chartered vessels have provided some data to the national government. The industrial survey carried out by *M.T. Murena* has indicated the potential off the north-west coast. More recently F.O.R.V. *Sagar Sampada* has carried out several cruises in the entire EEZ and beyond. It is high time that a fresh critical appraisal is made using all the national data available now with various agencies and up-date our knowledge on the potential resources and annual stocks. This would help in planning future development programmes in the E.E.Z.

Outside the limits of the continental slope, the projected major resources are the tunas and the oceanic squids. The mesopelagics and bathypelagics, although their resources are estimated to be large, cannot be exploited economically at the present level of harvest and post-harvest technology. Silas and Pillai (1982) and Silas (1985 a, ed.) have indicated the potential of tunas and related species in the Indian ocean and the Indian EEZ. Already commercial tuna fishing has been initiated in India. Some amount of survey data have also recently become available on the tuna resources of Bay of Bengal and Arabian Sea based on the operations of Government of India vessels. Joint ventures in tuna fishing are likely to come up. The interest has to be sustained and guided for proper management and development of tuna fisheries. Tuna is a global fishery with a multinational character and India's strategy should include a development of internal market for tunas and tuna products to offset any adverse global trends.

With regard to oceanic squids, all the information in respect of Arabian Sea and Bay of Bengal is indicative of vast resources, based on acoustic survey and experimental hand-line fishing. Oceanic squid fishery is based on specialised technology and in many parts of the pacific and Atlantic, distant water fishining vessels of Japan, ROK, Spain and U.S.S.R. operate for cephalopods under licence or joint venture. Silas (1985 b, ed.) has given detailed information on the cephalopod resources of India and indicated the perspectives. Joint venture in this area seems inescapable as a practical approach to development of oceanic squid fishery in the EZZ.

Management of information

Within the country, during the last 40 years, a large volume of information has been generated on the fishery resources, their biology, environment, fishery characteristics, technology of production, preservation and processing, marketing and utilisation. Apart form historical interest, these data are valuable today. In the present stage of better understanding of prospects and problems of Indian fisheries, both in capture and culture, past information is also found useful in one way or another. Current information generation is even greater and faster with several agencies engaged in marine fishery and related activities, including research, development, industry and management. However, it is doubtful if the information in a processed or unprocessed form is readily available to one who has the most need for it. In the national interest, it is necessary that information of unclassified nature is speedily made available for planning and programming marine related activities in the country. The fisherman, entrepreneur, planner, developer, manager, evaluator and scientist are all handicapped for lack of a system which can retrieve data and provide in a reasonable time. This results in loss of time and improper assessment of situations and, may be, expensive unwise decisions at times. A strong, reliable data-base is very vital for planning, management and development of the marine fisheries. It is suggested that there should be a national policy management of fishery related information and strategies are to be developed for handling different categories of information with adequate infrastructure and modern equipment.

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