Status of Fishing Technology in Andhra Pradesh

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The fishing industry in Andhra Pradesh has grown substantially over the years with intensification of the fishing effort and diversification in the fishing practices, contributing significantly to the social, economic and nutritional wellbeing of the people of the state. The state contributes 7.5% of the total fish production in India and ranks 1st in coastal aquaculture, 2nd in inland fish production and occupies 1st position in marine products exports. Different methods of fish harvesting are in vogue in capture fisheries sector of Andhra Pradesh. They range from gears like gill net, trammel net, shore seine, boat seine, fixed stake net, cast net and hook and line, long lines to trawling. Crafts used in Andhra Pradesh range from the traditional catamarans, canoes, stitched boats, and navas to mechanized trawlers. There has been a rapid expansion of both the non-mechanized and mechanized fleet over the past four decades. As a result of this unbridled expansion, catch per unit effort has fallen drastically over the years, highlighting the need for a scientific management of resources in order to ensure economic viability of fishing and long-term sustainability of resources. The paper highlights the present status of fishing technology development in Andhra Pradesh and CIFT's initiatives in development of harvest technologies. The paper also discusses the future strategies for developing responsible and sustainable fisheries in Andhra Pradesh.

Key words : Trawl, gill net, hook and line, shore seine, boat seine, harvest technology, Andhra Pradesh

Andhra Pradesh is endowed with a vast array of marine and inland aquatic resources. The state has a coast line of 974 km with continental shelf of 33,227 km^2 with rich pelagic and demersal fishery resources. In addition to the two main rivers Krishna and Godavari, their confluence points with the Bay of Bengal provides an estuarine environment that has major resources of creeks, canals and swamps. Total water spread area of reservoirs suitable for fish culture is 0.65 million ha, tanks for

fish culture is 0.725 million ha and a total of 90,567 ha of agricultural land and 2,837 ha of mangrove area have been converted to shrimp farms.

The brackishwater shrimp production has gradually increased from 27,138 t in1995 to 44,856 t in 1999. The fish seed production has increased from 453 million in 1991 to 752 million in 1999. The total inland fish production in Andhra Pradesh has increased from 31,145 t in 1991 to 1,02,089 t in 1999.

The fishermen population in the state is estimated to be around 0.871 million. There are 0.142 million fishermen actively involved in fishing, while 0.135 million are engaged in part-time fishing and 0.45 million in allied activities of fishing industry. Andhra Pradesh is producing 0.15 million t of fish from marine sector against the resource potential of 0.4 million t. Andhra Pradesh contributes 7.5% of the total fish production in India, ranks 1st in coastal aquaculture, 2nd in inland fish production and occupies 1st position in marine product exports contributing significantly towards the country's foreign exchange earnings.

Status of fishing technology in Andhra Pradesh

Different methods of fish harvesting are in vogue in capture fisheries sector of Andhra Pradesh. The gears for harvesting range from gill net, trammel net, shore seine, boat seine, stake net, cast net and hook and line, troll line to trawling. The fishing crafts used in Andhra Pradesh range from the traditional catamarans, stitched boats, canoes, navas to mechanized trawlers. Fishing operations in the pre-independent era were carried out using non-mechanized craft and cotton nets. Mechanized fishing operations were initiated after the independence. There has been a rapid expansion of both the non-mechanized and mechanized fleet over the past four decades.

Fishing vessels

Mechanization of fishing craft in the state was initiated during 1960s. Wooden boats with inboard engines were first introduced at Kakinada in 1964. *Pablo* designs (9.14m) used for trawling within 20 m depth, without mechanized winch, *Pomfret* design (9.75 m LOA, 45-65 hp) equipped with mechanized winch, *Sorrah* (11.4 m LOA, 60-75 hp) and *Sona* (13.1m, 102 hp) designs equipped for voyage fishing were subsequently introduced. Mini-trawlers (16 m LOA, 145-180 hp) and large trawlers (21-28 m LOA, 350-624 hp) designed to exploit resources in deeper waters were introduced in 1970s. Mexican style double rig trawling system was used in mini-trawlers and large trawlers. In the beginning, the mechanization was totally Government sponsored programme. The co-operative and private sectors started the mechanized fishing, subsequently (Satyanarayana and Narayanappa, 1972; FAO, 1993)

Fishing gear

A wide variety of fish harvesting methods were developed in the capture fisheries sector of Andhra Pradesh. Gill nets, trammel nets, stake nets, shore seines, boat seines and hook and lines are the major gears employed in the traditional sector to exploit inshore fishery. The mechanized vessels were used for trawling.

Gill nets

Gillnetting is a popular fishing gear extensively used in the traditional sector in Andhra Pradesh. About 91,000 gill nets are being operated along the coast of Andhra Pradesh (state fisheries statistics, 2002). Rao *et al.* (2002) has studied various designs of gill nets operated along Andhra Pradesh coast. Gill net fishing in Andhra Pradesh coast is carried out from catamarans, *masula* boats, plank built *nava* and fibreglass boats. In Visakhapatnam and Srikakulam districts, motorized and non-motorized catamarans and stitched boats are widely used. Plank-built boats fitted with inboard engine and catamarans with outboard engines are operating gill nets in other districts of Andhra Pradesh. At present fibreglass boats are commonly used along east coast for gill net operations. Cotton nets are completely replaced by synthetic gill nets. Polyamide monofilament and multifilament gill nets are widely used as surface drift, mid-water and bottom set nets. Polyamide multifilament gill nets are mostly used to catch small sized fishes like sardines and anchovies. Monofilament nets are widely used to catch seerfishes, catfishes, carangids, pomfrets, mackerel and polynemids. In the motorized sector, the wooden and FRP vessels equipped with 5-10 hp engines are used to operate HDPE gillnets of thicker twine in deeper waters to exploit bigger fish like seabass, seerfish and serranids. Three layered nylon trammel nets are used to exploit shrimp in coastal waters (Rao *et al.*,1980; Luther *et al.*,1988; Narayanappa *et al.*, 1991).

Shore seines

Among the indigenous gears, shore seines are operated during a particular season to catch inshore fishes. About 87,276 seines are being used in Andhra Pradesh. Two types of seines, one with and other without codend, are operated along the coast of Andhra Pradesh. The seines without codend are locally called as *Alivi vala*. The net consists of wall of netting with tapering ends. The seines with codend called *Pedda vala* has very long wings, with its depth gradually increasing towards the middle. These nets when they were first introduced in 1963, were made with cotton and later substituted by polyamide. Sardines,

anchovies, carangids, tunas and seerfishes are the commonly occurring shore seine catches (Rao *et al.*, 1985).

Boat seines

Boat seines are operated with two small boats. This is a bag shaped net with long wings, fabricated using polyamide netting of small mesh size. This net is operated in shallow waters up to 10-12 m depth. *Acetes* spp. and coastal finfish resources are exploited. Large quantities of juveniles are also caught in this net (Rao *et al.*, 1985).

Stake nets

Stake nets are bag shaped nets with small mesh codends. These nets are set against the tidal currents and kept in position using stakes of bamboo or casuarinas. Stake nets with small mesh codend operated off Kakinada were found to cause juvenile fish mortality (Rao *et al.*, 1991).

Hook and line

Hook and line fishing method is widely used to exploit predatory fishes. Lines of polyamide monofilament twine with round bent hooks of size ranging from No.1 to 16 are generally used. Non-motorized catamarans carry small units. One end of the line is held by fishermen in the boat while the other end having 3-4 hooks and stone weight is thrown into the sea and hauled in after a few minutes of towing. The lines are again put into operation, after removing the fishes caught. Motorized boats in deeper waters operate long units. The use of artificial lures made with coloured nylon threads are used to exploit mackerel and carangids. Lures made with plastic white strips are mainly used to catch tuna. Hand lines are operated in shallow waters. Tunas, seerfishes, sailfish, sharks, catfishes and dolphin fish are the commonly caught predatory fishes by this method of fishing (Rao *et al.*,1989).

Trawls

Bottom trawling provides a major portion of marine fish and is known to be a very effective fishing method for harvesting shrimps and demersal fishes. About 1,738 trawlers are operating in Andhra Pradesh. *Sona* boats of 13-15 m LOA powered with 68-98 hp engines are mostly used to exploit demersal resources up to 100 m depth. Single-day and multi-day fishing trips ranging from 3-15 days are undertaken by mechanized trawlers. *Sona* boats are deployed for stern trawling with bottom otter trawl and a pair of otter boards. Mini-trawlers operate

two trawl gears simultaneously from out-rigger booms. Four nets, two nets each from each of the outrigger booms are operated from large trawlers.

Sebastian *et al.* (1965) conducted comparative fishing experiments with beam trawl and otter trawl to exploit shrimp, off Kakinada coast. Narayanappa (1965) worked on the optimum length of bridles for otter trawl. Narayanappa (1968) studied the relative efficiency of different types of otter boards used for bottom trawling. Sreekrishna and Narayanappa (1970) worked on the trend of shrimp catches in bottom trawls . Satyanarayana *et al.* (1970) worked on the relative utility of different methods to increase the vertical height in an otter trawl. Satyanarayana *et al.* (1972) studied the comparative efficiency of four-seam and a two-seam trawls on the east coast. Narayanappa and Satyanarayana (1972) studied the optimum buoyancy-weight relation for a bottom trawl. Narayanappa *et al.* (1974) studied demersal trawl resources in the inshore waters off Kakinada. Satyanarayana and Narayanappa (1976) evaluated a three panel double trawl net. Satyanarayana *et al.* (1985) studied the scope ratio required for trawling off Kakinada. Rao *et al.* (1985) described the relative efficiency of Mexican type otter boards compared to the conventional flat rectangular otter boards. Narayanappa *et al.* (1985) studied the performance of high opening trawls and bulged belly trawls. Rao and Narayanappa (1974) and Rao *et al.* (1994) evaluated the performance of rope trawls in inshore and deep waters. Rajeswari *et al.* (1998) studied the impact of codend mesh sizes of trawls off Visakhapatnam. Rajeswari *et al.* (1999) reviewed the trawl landings off Kakinada coast.

CIFT's initiatives in developing fishing technology in Andhra Pradesh

Central Institute of Fisheries Technology (CIFT) was established in 1957 at Cochin with a mandate to develop innovative technologies for harvesting and optimum utilization of aquatic resources. The Research Centre of CIFT was established at Kakinada (Andhra Pradesh) in 1962. The Research Centre was shifted to Visakhapatnam in 1995. Ever since its inception, the research centre has been actively engaged in research leading to introduction of new and improved harvesting techniques in the east coast.

The Research Centre introduced *FishTech - 1*, a wooden hulled fishing vessel of 9.5 m LOA fitted with 36 hp equipped for gillnetting and long lining and *FishTech VII*, a wooden hulled fishing vessel of 12.16 m LOA fitted with 90 hp equipped for demersal trawling in 1963 (Table 1), for conducting experimental fishing operations. Recently, a multi-purpose steel trawler *CIFTECH-1* of 15.5 m LOA with 120 hp, equipped for trawling, gillnetting and lining was introduced to conduct experimental fishing.

Table 1. Fishing vessels introduced by Research Centre of CIFT in Andhra Pradesh

Name of vessel	LOA, m	hp	Year of introduction
FishTech - I (Wooden gillnetter-cum-longliner)	9.50	36	1963
FishTech - VII (Wooden trawler)	12.16	90	1963
CIFTECH - I (Steel trawler-gillnetter-liner)	15.5	120	2003

The Research Centre initiated trawling from small-mechanized boats and developed suitable trawl nets, otter boards and accessories. The centre has developed two seam trawls of 12.96 m and 11.89 m head rope suitable for shrimp trawling from *Pablo*, *Pomfret* and *Sorrah* boats up to 20 m depth. In 1973, the mechanized *Sona* boats started voyage fishing and started harvesting resources up to 100 m depth zone. The Research Centre has developed various designs of 20-30 m demersal and midwater trawls for shrimp and fish harvesting. Suitable designs of trawls, otter boards and accessories were developed for mini-trawlers and large fishing vessels. Midwater trawl of 50 m head rope and high opening trawl were developed for large fishing vessels and experimental operations were conducted in the Indian EEZ from research vessel *FORV Sagar Sampada*. After extensive field testing and statistical evaluation, the successful technologies were extended to the fishing industry, supporting the development process.

Technological improvements in traditional fishing gears

Gill nets

Mesh size and hanging coefficient for polyamide and HDPE gillnets for harvesting of seerfish, pomfret and mackerel were optimized. Effect of colour of netting on the catching efficiency of gill nets was studied. Experimental fishing were conducted to determine selective action with respect to twine type, colour of netting, phase of moon and depth of operation, using surface drift and bottom drift gill nets. Polyamide gillnets of 110 mm and 130 mm mesh contributed 21% of the seerfish catches during experimental operations and netting with twine size of 210Dx8x3 and 210Dx9x3 were found efficient for harvesting larger size groups. The depth ranges of 40-50 m was found to be relatively more productive for seerfishes. Gill nets with 150 and 170 mm mesh size made of polyamide netting of twine size 210Dx6x3 were found to be more efficient for harvesting sharks.

Gill nets for pomfret and hilsa were fabricated using polyamide netting of 210Dx6x3 twine size and nets with a hung depth of 6-7.5 m and mesh size of 110 mm and 120 mm mesh size were observed to be more efficient. Studies were also conducted on polyamide and polyethylene gill nets with 110 and 150 mm mesh size for harvesting crabs. Experimental results have indicated that gillnets with 110 mm mesh size were most efficient for crab fishing (Rao *et al.*, 1985).

Multi-mesh gill nets

Multi-meshed gillnets with three different mesh sizes of 30 mm, 40 mm and 50 mm with depth-wise arrangement were operated off Kakinada, along with traditional gill nets of same dimensions to evaluate the relative catch efficiency of the different mesh sizes (Narayanappa *et al.*, 1991). The bottom layer contributed 41%, middle layer 36.5% and upper layer 22.5% of the gillnet landings. Multi-mesh gill nets were found to be suitable for harvesting heterogeneous group of fishes.

Stake nets

Stake nets operated in Kakinada region with small meshed codends proved to be detrimental to juveniles. Earlier, cotton netting was used for fabrication of stake net which had short service life and needed frequent preservative treatment. A new design of stake net fabricated using polyethylene twisted monofilament was introduced, substituting polyethylene for cotton as netting material. The new design could withstand the strong tidal flow and gave the better catch rate of fish and shrimps (Rao *et al.*, 1991).

Long lines for sharks

A survey of shark long line along Andhra Pradesh and Orissa coast was conducted. Shark long lines with 3-5 mm dia synthetic main lines and indigenous and imported swan neck and kirby bent hooks of No. 1 and 2 sizes were operated, using fish, squid and beef, as baits (Rao *et al.*, 1989).

Studies on otter boards

Horizontally and vertically curved otter boards and V-shaped otter boards were operated to compare their efficiencies under identical fishing conditions (Narayanappa, 1968). The gear operated with V-shaped otter boards performed better, followed by the gear fitted with horizontal curved boards. Vertical curved boards were efficient for midwater trawling. V-shaped otter boards proved to be efficient in rough and uneven grounds, as they are able to ride over obstacles.

These boards were found to be inherently stable, hydrodynamically efficient, and gave relatively long service life. In another study, performance of flat rectangular, horizontally curved and oval otter boards were evaluated. Horizontally curved otter boards provided more horizontal spread than the other two designs, indicating its superior hydrodynamic efficiency, due to the camber incorporated in the design.

Optimum buoyancy-weight relation of bottom trawl

Comparative fishing operations were carried out with 0.55, 0.75 and 1.00 buoyancy-weight ratio, using a polyamide bottom trawl (Narayanappa and Satyanarayna, 1972). The total catch per trawling hour with 0.75 buoyancy-weight ratio was 16.5% and 32.08 % more than that with 0.55 and 1.00. The percentage of off-bottom fishes were more when buoyancy-weight ratio was 1.00 and bottom fishes dominated when ratio was 0.75. Bottom fishes like soles, shrimps, skates and rays dominated when ratio was 0.55.

Methods to increase the vertical height in an otter trawl

For the effective exploitation of off-bottom fish, trawls with greater vertical height are more suitable. To increase the vertical height of two-seam trawls triangular gussets, rectangular kites, additional float line and side panels with wedge-shaped wing-ends were used (Satynarayana *et al.*, 1972). The use of additional float line was found to be more effective in increasing catch. The trawls with additional float line and wedge-shaped wing-ends were efficient in harvesting both bottom as well as off-bottom fishes.

The optimum length of bridles for otter trawl

The use of bridles between the net and otter boards was introduced to increase the horizontal spread of the net (Narayanappa, 1965). To determine optimum length of bridles, three bridle lengths, *viz.*, 15m, 20m, and 25 m were evaluated for comparative performance. Among the three bridle lengths, 20 m was to be the optimum length for single bridles, to maximize the horizontal spread of the net and catch per unit effort.

Scope ratio studies

The ratio of length of warp to the depth of operation is known as scope ratio. Scope ratio studies were conducted using 20 m bulged belly, 20 m four-seam and six-seam trawls with flat rectangular otter boards (Satyanarayana *et al.*, 1985). The results indicated that a scope ratio of 1:7 to 1:8 was best-suited up to 20 m depth, 1:5 to 1:6 between 20 and 50 m, and 1:4 at depths above 60 m.

Trawl resources off Kakinada

Experimental shrimp trawling was conducted in two depth ranges, *viz.*, 15-50 m and 51-100 m to study the relative catch rates (Narayanappa and Raju, 1974). The catch rate was found to be nearly 5.7 times higher in the 51-100 m zone than that in 15-50 m zone. The warp tension of trawl recorded was 17% more in 51-100 m range compared to 15-50 m depth range. The catch per unit effort of shrimps at different depths was recorded by using 12.9 m two seam trawl during 1963-66, from the 9.1 m 36 hp *FishTech No 1*. The mean catch per trawling hour of shrimp obtained during the experiments was 12.3 kg.

Comparative efficiency of four-seam and a two-seam trawls

Fishing experiments were undertaken to compare the performance of a four-seam net with a conventional two-seam net (Satyanarayana *et al.*, 1972). The four-seam net gave 6-8% higher catch with a higher percentage of fish. Horizontal spread realized by four-seam net was less than that of two-seam net. The warp tension remained more or less the same in both the nets.

Comparative efficiency of shrimp trawl designs

Comparative fishing experiments were conducted using a 29.26 m long wing four-seam and 18.25 m two-seam trawls, off Kakinada (Satyanarayana *et al.*, 1972). Percentage contribution of fish and shrimps was found to be better in long wing trawl. The catch rate was found to be higher when the buoyancy-weight ratio was maintained at 0.75 for both the experimental nets. The catch per unit effort for shrimps was almost two times more in the long wing trawl.

Three panel double trawl

A three-panel double trawl with twin codends was used to study the utility of the net in catching both bottom and off-bottom fishes (Satyanarayana and Narayanappa, 1972). The bottom resources such as shrimp, sole and sciaenids were caught in the lower codend, while off-bottom fishes like *Lactarius* sp., ribbonfishes, carangids and pomfrets were caught in the upper codend.

Bulged belly trawls

Performance evaluation of three different sizes of 20 m, 25 m and 30 m bulged belly trawls was conducted (Narayanappa *et al.*, 1985). Otter boards constituted 15- 20 % of the drag of trawl system. Experiments were conducted with a bulged belly design with three different wing heights, *viz.*, 20 meshes, 40 meshes and 60 meshes with varying distances between otter boards and

different vertical heights. 20 meshes wing height had given highest catch per hour.

Rope trawls

In rope trawls, the leading sections of net body were substituted by ropes of sufficient breaking strength (Rao and Narayanappa, 1974; Rao *et al.*, 1974). Substitution of netting with ropes in the front panel sections reduced the drag of the trawl. Lower drag of rope trawl could contribute to faster towing speed and facilitate capture of fast swimming fishes. Fuel economy and ability to harvest fishes such as pomfrets, ribbonfishes, anchovies and sciaenids indicate its suitability for commercial fish trawling.

High opening trawl

Trawls with four, six and eight seams were designed to obtain higher vertical opening in order to catch fish species with a pronounced vertical spread of the shoals. A 20 m high opening trawl has given 1.64 times better performance than the bulged belly trawl (Narayanappa *et al.*, 1985).

Bycatch reduction devices

Trawling accounts for a high rate of bycatch, along east coast. Bycatch reduction devices could be used to minimize the catches of non-target species and juveniles. Bycatch reduction devices like square mesh windows and square mesh codends were designed and installed in shrimp trawls, in order to reduce the retention of juveniles in shrimp trawls (Rajeswari *et al.*, 2004).

Turtle excluder devices

Protected animals such as sea turtles are caught incidentally during trawling. Trawling is reported to account for over 13% of the incidental catch of turtles (Rajagoplan *et al.*, 1976). Turtle excluder devices (TEDs) have been developed to exclude sea turtles caught in trawls. CIFT has developed an indigenous turtle excluder device, appropriate for Indian fishing conditions, which is named as CIFT-TED (CIFT, 2003). The CIFT-TED is a simple, hard TED design with top opening installed in front of the codend of trawl. While dragging the trawl, shrimp and fish slip through the grid bars and are retained in the codend. Turtles are stopped by grid bars and escape through the exit hole, provided. The CIFT-TED has been successfully demonstrated to trawler fishermen along Andhra Pradesh, Orissa and West Bengal on the east coast and has proved to be highly efficient in protecting sea turtles during trawling operations, with minimum catch loss.

Fish aggregating devices

The pelagic and demersal fish resources have generally declined or remained stagnant as a result of uncontrolled expansion of fishing effort. One of the approaches towards enhancement and management of coastal fishery resources is by deployment of fish aggregating devices (FAD). CIFT has evaluated FADs constructed of truck tyres deployed in 20 m depth, off Jodugullapalem, Visakhapatnam (Rajeswari, this volume). Installation of FADs helps to rehabilitate the depleted fish stocks, thus reducing scouting time expended and enhancing income from fishing.

Semi-pelagic trawls

Trawl fisheries in the state as elsewhere in India, is generally shrimp-oriented. The excessive pressure exerted on the seabed by the heavily rigged conventional bottom trawls has a negative impact on the benthic organisms and small meshed netting used in its construction caused juvenile fish mortality. Environment-friendly semi-pelagic trawls of 25 and 30 m head rope length were developed to address some of these issues and evaluated, off Visakhapatnam. These trawls minimized the catch of non-targeted fishes, reduced the impact on seabed and caught high value off-bottom fishes, such as pomfrets, carangids, ribbonfishes, and cephalopods.

Trawl selectivity studies

Trawls are known to be less selective compared to other fishing gears and lands a wide spectrum of bycatch species including juveniles. The FAO code of conduct for responsible fisheries has highlighted the need for research leading to improvement in selectivity of fishing gear systems (FAO, 1995). Bottom trawl of 30 m head rope length was used for studying whole trawl selectivity and 30 mm to 120 mm square mesh codends were used for codend selectivity studies. Sardines and anchovies were observed to be escaping through trawl panels.

The authors are grateful to the Director, Central Institute of Fisheries Technology, Cochin for his kind permission to publish this paper and to Shri. C. Sriharibabu and Shri. K.V.S.S.S.K. Harnath, for their help in collecting the field data.

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