1. **INTRODUCTION**

The present world is witnessing a resurgence in the consumption of fish and shrimps. This spurt has been attributed mainly to technological innovations in fishing harbours, shore facilities, processing plants, cold storages, transportation and also in aquaculture.

India has a coastline of 8129 Km (Bhatnagar and Manocha, 1993), continental shelf area of 4.5 lakh sq.m. and Exclusive Economic Zone (EEZ) of 2.02 million sq.km. The marine capture fishery resources potential was estimated to be 3.9 million tonnes and in 1992-93 the quantum of fish landings was estimated to be 2.4 million tonnes (Fact Sheet, 1993). The estimated shrimp seed production was 0.08, 0.10, 0.15, 0.35, 1.00 and 1.50 billion in 1989, 1990, 1991, 1992, 1993 and 1994 respectively (MPEDA, 1995).

Fisheries development took place in a planned manner since 1951. Deep sea fishing and aquaculture development with an export orientation received considerable attention since the Fourth and Fifth Plans respectively. The Fifth plan inaugurated the setting up of Fish Farmers Development Agencies (FFDA) to promote intensive aquaculture through fish farmers in selected districts. In the Seventh Plan (1985-1990), thrust in prawn farming of brackishwater areas was emphasised by establishing ‘Area Development prawn farming estates’. In 1988-89, nine brackishwater FFDAs were sanctioned. In the Eighth Five year Plan (1992-97), it has been proposed to reach fish production level of 2.7 lakh tonnes as against the total potential of 4.5 million tonnes (Francis, 1993).
The Marine Products Exports Development Authority (MPEDA) has taken keen interest in the development of shrimp farming to augment export production. It provides subsidy for new farmers development, establishing shrimp seed banks, shrimp hatcheries and shrimp feeds apart from rendering technical assistance and training for scientific shrimp farming (MPEDA, 1993).

Fisheries recieved a development impetus in the recent past. However, the progress made has been unsatisfactory in several respects. Cultured shrimps in India increased from 4000 to 23,500 MT from 1975 to 1988 respectively. It is interesting to note that in China, cultured shrimp production was not significant in 1975 but a phenomenal increase was observed from 2000 to 1.8 lakh MT from 1980 to 1988 respectively.

In India, the initial steps for augmenting marine products exports were taken by the Ministry of Food and Agriculture in 1957-58. The Government constituted the Marine Products Exports Council in 1961 which was reconstituted in 1972 as MPEDA. It is responsible for planned and regulated development of Indian Sea Food Industry. MPEDA entered into technical collaboration agreements with reputed foreign firms for setting up of prawn hatcheries in India. It has also taken the initative to plan and execute several schemes involving quality control of processed seafood, maintaining hygiene and sanitation in the industry, marketing services, research and product development, publicity and market promotion.
A. Prospects of brackishwater aquaculture in India:

India has a total estimated brackishwater area of 1,190,000 hectares suitable for shrimp farming, of which only 70,700 ha. are utilised. The state-wise details and the area under cultivation according to ICICI & SCICI (1994) are given in Table 1.

B. Status of brackishwater aquaculture in India:

Brackishwater aquaculture on commercial and scientific approach started in India only in mid 1980's (ICICI & SCICI, op. cit.) Though, land was suitable for brackishwater aquaculture, only a few specific areas were found to develop, viz., Nellore in Andhra Pradesh, Tuticorin and Poompuhar in Tamilnadu and some places in Maharashtra and Goa. The state-wise details of brackishwater resources according to Srivastava et al. (1991) are presented below:

a. Andhra Pradesh:

It has a network of 172 brackishwater bodies in nine coastal districts. The total brackishwater area in the state is estimated at about 1.5 lakh ha. The State Government conducted a macro-level survey and identified 17,000 ha. of land belonging to Revenue, Salt, Forest Departments and private individuals. Krishna and East Godavari districts have maximum area for development. The State Government brought out policy for land allotment in 1980 encouraging all sections of society to get maximum benefits.
b. Goa:

Goa has 18,500 ha. of brackishwater area under traditional culture. A large area bordering brackishwater system in Goa has been reclaimed for agriculture during Portugese regime.

c. Gujarat:

It has a vast area of tidal mud-flats (3.76 lakh ha.) with high amplitude, of which around 360 ha. are under shrimp culture. The northern part is highly saline and the southern part with river discharge making the conditions congenial for brackishwater shrimp farming.

d. Karnataka:

The brackishwater area in Karnataka is estimated to be 8000 ha., of which around 2570 ha. are under traditional farming, mainly in Kumta region. Karnataka follows contract farming where land owners are not themselves directly involved in farming. The State Government is taking steps to introduce scientific shrimp farming.

e. Kerala:

The potential area estimated to be 65,000 ha. in Kerala for shrimp culture. However, 50% of this cultivable area is under traditional paddy-cum-shrimp cultivation. Heavy rain during south-west monsoon dilutes the brackishwater area to an extent that it becomes suitable to grow paddy during
June - September. During the rest of the period, the area remains brackish to utilise for paddy-cum-shrimp culture.

f. Orissa:

It has the largest brackishwater lake in the country (Chilka) with rich shrimp and fish fry resources. About 31,600 ha. of land has been found suitable for brackishwater culture. A large portion of the land (27,000 ha.) belongs to revenue and forest departments. Orissa Government has evolved a policy for land allotment in 1981 reserving 3/4th of area for weaker section. Shrimp seed resources in Chilka are presently being utilised rationally for farming to get maximum output.

g. Maharashtra:

Maharashtra has about 80,000 ha. of brackishwater area and the Government is taking progressive steps to distribute land to private entrepreneurs with liberal land allotment policy. About 1980 ha. are under brackishwater culture.

h. Tamilnadu:

In Tamilnadu, around 56,000 ha. of land has been estimated to be potential for shrimp culture (ICICI & SCICI, op. cit.). Substantial work has been done in Tamilnadu for developing brackishwater shrimp culture. The Adayar Brackishwater Fish Farm has established the techno-economic viability of shrimp culture. The Bay of Bengal Programme of FAO has worked on the
economics of pen culture in Killai backwaters. A few entrepreneurs in Pulicit lake near Madras have done commendable work despite adverse environmental conditions.

i. West Bengal:

The Sunderbans in West Bengal with an area of 4.05 lakh ha. have the greatest potential for farming tiger shrimps. The tidal amplitude, quality water, soil conditions and natural ingress of tiger shrimp larvae along with the high tide water into the estuary, provide the best conditions to culture tiger shrimp. Coastal aquaculture with paddy-cum-shrimp/fishes is an age old practice in West Bengal. Cultivation by this traditional practice is being carried out in an area of 34,050 ha. West Bengal stands first in the freshwater and brackishwater culture fisheries.

C. Global perspective in fisheries:

A substantial increase in fish production as a result of intensive and extensive capture and rapid development of semi-intensive and intensive culture has been noticed in the recent past. World fish production increased from 23.5 million MT in 1951 to 96.5 million MT in 1988 and reached 100 million mark in 1989. In 1990, it declined to 97 million MT. During the seven year period between 1981 and 1988, production increased by about 31%. The developed country that showed substantial increase in fish production is the U.S. The country's policy to exploit its own resources of Alaska led to one million tonne leap in landings between 1985 and 1988. In 1989, the developing countries accounted 55% of the total world fish catch. Remarkable achievement
has been made in China to the tune of 10.4 million MT in 1988. FAO forecasts the total world demand for fish by the end of the century in the order of 100-110 million MT (Francis, *op. cit.*). Farmed fish made its significance since early eighties. FAO estimated that aquaculture products will reach an annual output of 22 million MT by 2000 A.D. It implies that aquaculture supplies will increase from 13% to 25% of the total fish supplies. In 1981, farm shrimp accounted for 2% of the world’s shrimp harvest and rose to 27% by 1995 (Shrimp News International, 1995). New species (*Penaeus monodon*) holds 33% share of the farmed shrimp in South East Asian countries. In 1988, more than 40 countries were engaged in shrimp culture in over 765,000 ha. The top producer was China followed by Ecuador and Thailand.

D. International trade in seafood:

Over the last three decades, a rise in international trade in seafood was noted. It jumped from 16 billion $ in 1980 to 33 billion $ in 1989. It is estimated that one third of world’s fish production enters international trade in any one form comprising of fishes, crustaceans (mostly shrimps) and cephalopods. In 1969, shrimps accounted for 18% of the value of export. The three major markets for seafood are Japan, U.S.A. and Western Europe. All the major markets have trade links with major importers due to political, cultural or geographical factors.
i. Japan:

The country stands first in fish importing as compared to the other nations of the world. Seafood imports to Japan rose from 5.4% in 1986 to 5.8% in 1987 and 5.84% in 1980. In 1986, around 35% of Japanese imports were cultured shrimps. In 1988, imports were valued at 11,75,429 million yen. Shrimp represented 23% of this total. The per capita consumption of shrimp in Japan is higher than in U.S. Japan relies on foreign supplies to fill 90% of her shrimp requirements. Three fourth of Japan's imports of shrimp originate from Indo-Pacific region. In 1989, an over supply was noted due to aquaculture venture (Francis, op. cit.). In 1991, the imports further raised to 284,913 MT (ICICI & SCICI, op. cit.).

ii. United States of America:

It is the second largest importer of seafood in the world. It is estimated that over 80% of seafood consumed in U.S. was imported in 1990. Imports of seafood to US come from 110-120 different countries. Growth in exports from Asia for shrimp products have been in the increasing trend in the recent years with the expansion of shrimp farming. China leads in shrimp exports to US apart from its major bulk being exported to Japan. The per capita consumption of shrimp in US increased from 0.77Kg in 1980 to 1.27Kg in 1988 and is expected to increase above 2Kg by 2000 A.D.(Francis, op. cit.). The other major exporters of shrimps to the U.S. in 1991 were Ecuador (107,435 MT), Thailand (100,058 MT), India (38,528 MT) and Mexico (36,623 MT) (ICICI & SCICI, op. cit.).
iii. China:

The production of cultured shrimp increased markedly during the last decade since Government has imposed measures to control over exploitation. About 163,000 ha. in 1988, were developed for culture activities and yielded 1230Kg/ha. as against 285Kg/ha. in 1980 with 9300 ha. Shrimp production increased to 140,000 MT in 1992. However, it declined to 70,000 MT in 1995 due to environmental and technical constraints (Shrimp News International, op. cit.). In China, the principal species cultured are *Penaeus chinensis* and *P. orientalis*. Production levels of hatchery seed increased from 3.37 billion PL20 in 1988 (ICICI & SCICI, op. cit.). In 1988, the value of shrimp was estimated at US $ 600 million which is around 60% of the total fisheries exports. Its exports to USA accounted for 36,904 MT and to Japan to the tune of 33,585 MT in 1992 (Fact Sheet, op. cit.).

iv. Europe:

The European Economic Community (EEC) countries constitute the third largest importer of shrimps. These countries are divided into two broad groups, the Mediterranean and North European countries. The Mediterraneans prefer large sized, whole raw, shell and head on shrimps. The north Europeans prefer cold water species which are available locally. The main exporters to EEC are Greenland (31053 MT), Ecuador (27,909 MT), India (18,696 MT), Thailand (14,482 MT), Argentina (8,955 MT), Bangladesh (8,873 MT) and Indonesia (6,199 MT) (Fact Sheet, op. cit.).
v. Indonesia:

Indonesia has reported 250,000 ha. of brackishwater area under culture ponds in 1987. Traditional culture with milk fish are being converted to shrimp culture ponds. The main species cultured is the black tiger shrimp through capture landings including *Penaeus merguiensis* and *Metapenaeus* spp. In 1989, 120 hatcheries were in operation with a combined capacity of 2 billion seeds per year. In 1991, Indonesia has recorded 259,000 MT in shrimp production (Bhatnagar and Manocha, op. cit.). The Indonesian market exports its major goods to Japan followed by Hongkong, Singapore and USA. The involvement of Japanese companies in setting production and processing facilities in Indonesia resulted Japan’s dominant position as the principal market for Indonesian shrimp apart from geographical proximity, reliable transportation services and market acceptance of Indonesian products.

vi. Thailand:

The area under brackishwater shrimp culture increased from 30,000 ha. in 1984 to over 60,000 ha. in 1990. Shrimp production increased from 13,000 MT to 110,000 MT during this period reflecting a significant increase in yields. In 1994, production of cultured shrimp was around 225,000 MT and the country was ranked as the highest producer (Shrimp News International, op. cit.). The growth of black tiger took role and constituted 70% of the total output after mid 1980’s. Number of hatcheries, feed mills and processing plants with other business providing inputs and services were established. In 1994-95, the market declined and recovery of losses have become low due to high cost of shrimp feed, electricity and environmental problems due to over
crowding and over exploitation. Exports of frozen shrimp had grown from 21,627 MT in 1981 to 116,404 MT in 1990 with an annual growth rate of 20.6%. The Product includes about 68% of Block frozen shrimps, 26% value added form and 4% in fresh form. The major markets are Japan, USA, Singapore and EEC countries.

vii. Philippines:

In 1987, around 21,000 ha. of brackishwater farms were in operation under extensive culture with shrimp-milk fish culture or monoculture. The principal species cultured was *Penaeus monodon*. About 400 hatcheries were in operation for tiger shrimp. The country has the advantage of warm climate, existing operation in traditional farms, large area of land and trained labour force. High cost of imported shrimp feed and statutory regulations did not permit the development of new farms of more than 5 ha. size. In 1993, production declined to 25,000 MT as against 50,000 MT in 1989 (Shrimp News International, op. cit.).

viii. Taiwan:

In mid 1980s, Taiwan led the world in cultured shrimp production with 70% from Tiger shrimp followed by Kuruma shrimp (20%) and Red Tailed shrimp (5%). In 1988, the first major problem of disease set reduction in production of 30,000 MT as against 95,000 MT in 1987. The decline was due to weak seed stocking produced due to intensive culture, excessive respawning of broodstock, super-intensive stocking in pond, recycling of water, water
pollution, deterioration of pond bottom and disease outbreak. Hatcherries reduced from 2000 to 800 in numbers from 1988 to 1990, respectively.

ix. Vietnam:

It has a long coastline with 3,000,000 - 6,000,000 ha. of land suitable for pond construction. Traditional ponds were large and relied on tidal exchange for pond stocking. Vietnam produced 30,000 MT of cultured shrimp in 1989 (Arlo and James, 1992). Shrimp production gradually increased from 30,000 MT to 50,000 MT between 1989 and 1995 (Shrimp News International, op. cit.).

x. Malaysia:

It has a coastal length of 3400 Km and with scanty populated centres in the coastal belts estimating 16 million people. 269 MT of shrimp production by culture practices was recorded in 1986. Shrimp production failures have been reported in many areas due to acid sulphate soil problems. High cost in construction, labour shortage and Government policy caused the decline in shrimp culture industry (Arlo and James, op. cit.).

xi. Ecuador:

It accounts for 75% of Latin American output. The area of utilisation increased from 3000 ha. in 1977 to 124,000 ha. in 1989. Managed farms produced 2 tons/ha. as against the industrial average of 700Kg. Sixty hatcheries are in operation producing one billion PL20/annum. However, most
of the farms in Ecuador depend on wild seed. In 1989, the industry faced technical problem like inadequate feed for larvae, collection of spawners and disease outbreak. The country's main export is to USA and to European Economic Countries (Fact Sheet, op. cit.).

xii. Republic of Korea:

In 1987, republic of korea produced 48.4 thousand MT of shrimp (Penaeus chinensis) from 430 ponds. Shrimp production is severely limited by cold climate, scarcity of suitable pond sites and high development costs. However, production increased from 49.9 thousand MT to 55.8 thousand MT between 1988 and 1991. It represented 2% of the total world production (Bhatnagar and Manocha, op. cit.).

xiii. Burma:

In 1986, Burma produced 9,744MT from capture fisheries and 506 MT from cultured ponds. Political unrest, Government policies and economic constraints are likely to dampen shrimp culture development in Burma (Arlo and James, op. cit.).

xiv. Singapore:

It has a small land area. It has high per capita income, traditional seafood consumption and high prices for live-shrimps. In 1987, 95 MT were produced from 300 ha. ponds and floating cages (Arlo and James, op. cit.).
xv. Sri Lanka:

Shrimp culture in Sri Lanka began in 1985. It receded its activity due to political constraints. In 1986, cultured shrimp production was estimated to be 300 MT.

xvi. Pakistan:

Only 8 MT were cultured during 1986 as against 27,000 MT from capture fisheries. Lack of brackishwater culture tradition, suitable pond site, limited culture despite Government interest in its development had made shrimp production to be in slow progress.

xvii. Australia:

It produced 15 MT of cultured shrimp in 1986. Penaeid species include *Penaeus latisulcatus* and *Metapenaeus* spp. High labour costs, land utility restrictions, lack of aquaculture infrastructure were some constraints.

Based on the global scenario and the immense potential of shrimp culture in India, the present investigation has been undertaken to study the growth of shrimp hatcheries encompassing state-of-the-art-technology, concepts, designs, operation techniques, recent innovation in research and development, various parameters governing the boon and bane to the industry, and their status in the past, present and future.
Table 1. State-wise details of shrimp farming in India (1993-94).

<table>
<thead>
<tr>
<th>No.</th>
<th>State</th>
<th>Potential area (Ha.)</th>
<th>Area under cultivation (Ha.)</th>
<th>Level of exploitation (%)</th>
<th>Estimated production (MT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>West Bengal</td>
<td>405,000</td>
<td>34,050</td>
<td>8.40</td>
<td>16,300</td>
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<td>2.</td>
<td>Orissa</td>
<td>31,600</td>
<td>7,760</td>
<td>24.55</td>
<td>4,300</td>
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<td>3.</td>
<td>Andhra Pradesh</td>
<td>150,000</td>
<td>9,500</td>
<td>6.33</td>
<td>12,800</td>
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<td>4.</td>
<td>Tamilnadu</td>
<td>56,000</td>
<td>530</td>
<td>0.95</td>
<td>1,100</td>
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<tr>
<td>5.</td>
<td>Kerala</td>
<td>65,000</td>
<td>13,400</td>
<td>20.61</td>
<td>9,750</td>
</tr>
<tr>
<td>6.</td>
<td>Karnataka</td>
<td>8,000</td>
<td>2,570</td>
<td>32.12</td>
<td>1,150</td>
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<td>7.</td>
<td>Maharastra</td>
<td>80,000</td>
<td>1,980</td>
<td>2.48</td>
<td>1,050</td>
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<td>8.</td>
<td>Gujarat</td>
<td>376,000</td>
<td>360</td>
<td>0.09</td>
<td>200</td>
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<td>9.</td>
<td>Goa</td>
<td>18,500</td>
<td>550</td>
<td>2.97</td>
<td>350</td>
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<td>10.</td>
<td>Pondicherry</td>
<td>800</td>
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<td></td>
<td><strong>Total</strong></td>
<td><strong>1,190,900</strong></td>
<td><strong>70,700</strong></td>
<td><strong>10.94 Avg.</strong></td>
<td><strong>47,000</strong></td>
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