

2.0 Shrimp Aquaculture

2.1 Aquaculture - Definition

FAO¹ has defined aquaculture as “the farming of aquatic organisms, including fish, molluscs, crustaceans and aquatic plants. Farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc.” FAO in its Guidelines for the “Promotion of Environmental Management of Coastal Aquaculture Development”, has collectively termed the land-based and water-based brackish and marine aquaculture practices as ‘coastal aquaculture’². Aquaculture has also been defined as ‘the rearing of aquatic organisms under controlled or semi-controlled conditions’³. Further, the New



Encyclopaedia Britannica, has defined aquaculture as ‘the exploitation of a natural or artificial body of water for the growth of food products such as fish, molluscs and seaweed; when restricted to fish culture, it is frequently called fish-farming’⁴.

2.2 Biology of Shrimp

The popular names, shrimps and prawns, have been used variously to denote decapod crustaceans of the families Penaeidae and Palaemonidae. But in the recent aquaculture literature, a distinction has been drawn between the two groups. The name prawn is used for freshwater forms of Palaemonids and shrimp for the marine penaeids.⁵

There are more than 50 species/ varieties of shrimps available in marine waters, with a very wide distribution in both tropical and temperate ecosystems. Most are very small and not suitable for farming or human consumption. However, the giant tiger shrimp (*Penaeus monodon*), which is internationally known as tiger shrimp, has been and continues to be the leading cultured species. *P. monodon* is also the largest (maximum length 363 millimeters) and fastest growing of the farmed shrimp species. In India, other than *P. monodon*, species such as *P. indicus* (white shrimp), *P. penicillatus* (like white shrimp), *P. semisulcatus* (green tiger prawn) and *P. merguensis* (banana shrimp) are also farmed (Figure 1), but the two shrimp species – *P. monodon* and *P. indicus* form the mainstay of shrimp aquaculture in the country. Assured supply of seed from hatcheries is one of the main reasons for this dependence. In traditional systems of farming, minor penaeid shrimps, which enter along with the tidal waters are also cultured.

In other parts of the world, *P. vannamei* is the dominant species in South American countries and *P. chinensis* is the most popular farmed species in China. Most of the south and south-east Asian countries farm only *P. monodon*. Kuruma shrimp (*P. japonicus*), native to the Indian Ocean and the south-western Pacific Ocean is commonly farmed in Japan and Australia.

Shrimps mature and breed only in marine habitat. In the ocean, a single female shrimp spawns 100 000 – 500 000 eggs at a time. Within 24 hours, the eggs hatch into larvae, which feed on microscopic plants and

¹ FAO Year-Book: Fishery Statistics, Aquaculture Production. FAO 2000. Vol. 86/2. 1998.

² FAO 1992. Guidelines for the Promotion of Environmental Management of Coastal Aquaculture Development. FAO Fisheries Technical paper 328.

³ Mathew Landan, 1992. Introduction to Aquaculture. John Wiley & Sons Inc.

⁴ The New Encyclopaedia Britannica, 1998. Vol V.

⁵ T.V.R. Pillay, 1998. Aquaculture Principles and Practices. Fishing News Books.

Figure 1. Important Farmed Shrimp Species

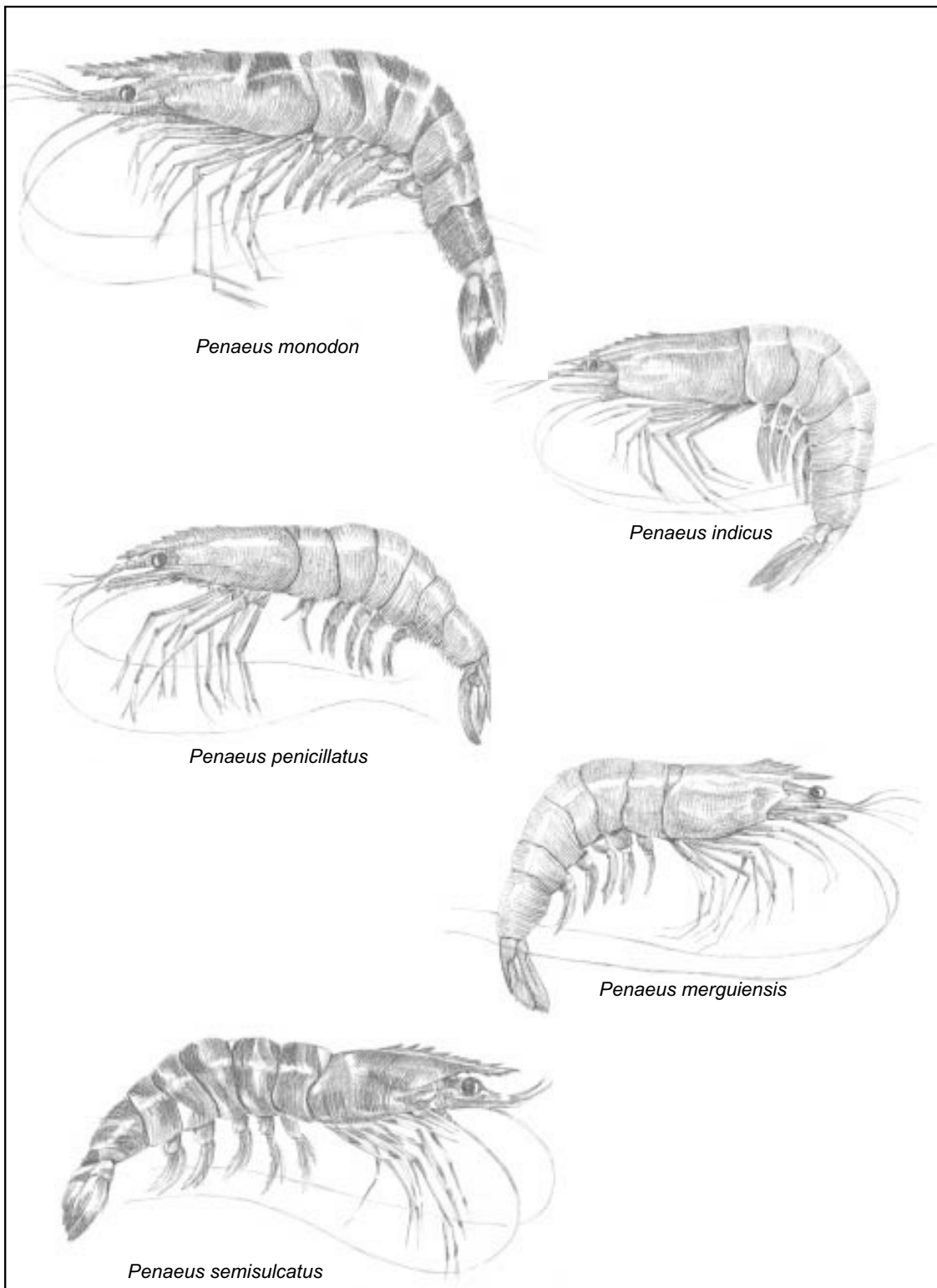
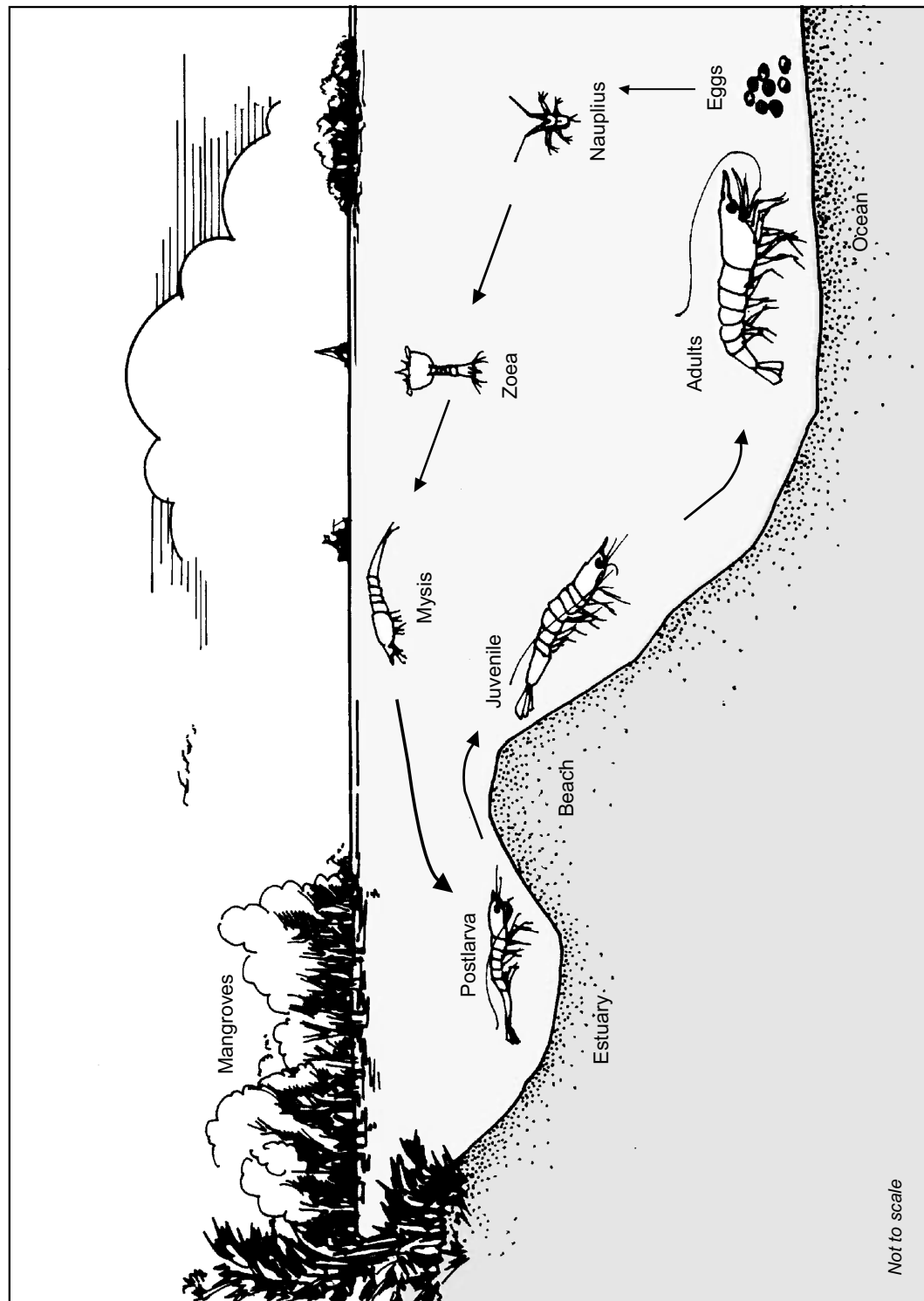


Figure 2. Life Cycle of Penaeid Shrimp



animals present in the water known as plankton. After passing through three stages and various sub-stages, in a period of about 12 days (Figure 2), the larvae develop into young shrimp known as postlarvae. These postlarvae tolerate wide range of salinity from slightly greater than freshwater (1 –2 ppt)* to full-strength ocean water (35-40 ppt). Postlarvae migrate to low-saline, nutrient-rich estuaries and backwaters where they grow from postlarvae to larger juveniles/ sub-adults. This phase of the life-cycle of the shrimps is used for farming. The juveniles then return to the sea to mature and breed, thus completing the lifecycle.

2.3 Farming Practices

In shrimp farming parlance, farmers refer to postlarvae as “PLs” and as each day passes, the stages are numbered PL-1, PL-2, and so on. When their gills become branched (PL- 13 to PL- 17) the postlarvae can be moved to the farm for raising to table- size. From hatching, it takes about 25 days to produce a PL-15.

Shrimps are generally cultured in land based ponds/ impoundments. To achieve this, the ponds are initially prepared by drying and tilling (to remove the pests and predators and metabolize the organic matter) and then liming (to correct the pH and to keep the bottom free from microorganisms). Inorganic fertilizers such as urea and super phosphate are then applied to develop the natural food organisms known as plankton (floating) and benthos (bottom living). The plankton in aquaculture ponds create turbidity and the water usually appears green or greenish-brown. This colour is maintained all through the culture period. After these preparations, shrimp postlarvae are stocked at varying densities (numbers per square meter) depending on the level of production. Pelleted diets with about 40% of protein is used as supplementary feed. The feed is provided in three different sizes depending on the size of the shrimp - starter, grower and finisher. The feed quantity to be given is monitored using feed trays and it is adjusted according to the level of growth. Water quality is continuously monitored and the optimum levels of important parameters such as dissolved oxygen, pH and salinity are regulated by resorting to periodical exchange of water. The rate of exchange depends on the number of shrimp stocked, and the quality of pond water. Some farmers resort to aeration of the ponds using mechanical/ electrical aerators. After continuous monitoring of the stock, they are generally harvested when they reach marketable size of 30 – 35 g. It normally takes about 4-5 months to achieve this size in tropical conditions. An average production of 500 kg – 1500 kg is expected per crop by adopting scientific farming practice in low input systems.

In traditional shrimp farming systems, the migrating postlarval stages are trapped in the brackishwater impoundments along with all other organisms present in the estuarine water and allowed to grow. With the introduction of scientific shrimp farming with selective stocking, the requirements for seed has increased and the controlled production of shrimp seed in sea water- based hatcheries is practiced all over the world.

Tiger shrimp and white shrimp require clean water for optimum growth and good health. Shrimps are primarily bottom dwellers and are easily stressed when exposed to poor pond conditions such as low pH, high organic matter concentration, and soft sediment containing reduced microbial metabolites. When shrimps are stressed they are susceptible to many diseases, especially to viral diseases. The primary objective during culture is to provide a good quality environment in ponds to prevent stress, minimize the risk of diseases, and to enhance survival rate and production.

Commercial shrimp farming, the production of marine shrimp in impoundments, ponds and tanks, started in the early 1970s, and today, over fifty countries export farmed shrimp. In Ecuador, the leading producer in the western hemisphere, export revenues range from US \$400 to US \$800 million a year. In Thailand, the leader in the eastern hemisphere, they have passed the billion dollar mark. In addition, Indonesia, India, China, Malaysia, Taiwan, Bangladesh and Sri Lanka all produce huge amounts of farmed shrimp. The Philippines, Vietnam and Myanmar have shrimp farms, and there are shrimp farms throughout Central and South America. The shrimp importing nations-the United States, Western Europe and Japan-specialize in high-tech “intensive” shrimp farming, but productions are not of higher magnitude.

* ppt – parts per thousand (gram / litre)

3.0 Shrimp Aquaculture - Global and Indian Scenario

3.1 Introduction

Aquaculture has developed rapidly over the last three decades to become an important economic activity world-wide. It has confronted many of the developmental problems in this relatively short period including sector competition, over production, trade restrictions, over-capitalization and concerns over environmental impacts. The significance of aquaculture in the context of global food production sector, the management of aquatic resources and the socio-economic development of coastal rural areas is now fully appreciated world-wide. Significant advances have also been made globally to make shrimp aquaculture development responsible and sustainable.



Global aquaculture production increased from 6.7 million tonnes in 1984 to 28.3 million tonnes in 1997. It is sure to accomplish the projected deficit of many millions of tonnes of sea food for human consumption since capture fisheries has reached the maximum sustainable yield. Aquaculture is also steadily growing in other countries such as Norway, Scotland, Ireland, Iceland, Japan, Canada, Chile, Australia, New Zealand and United States of America.

3.2 The Global Scenario

Shrimp farming is relatively new and its introduction on a commercial-scale can be traced back to the early seventies. Despite its relative newness, one-third of world shrimp production is now from farmed shrimp. During the last 14 years from 1984 to 1997 some 63 countries are listed in FAO aquaculture statistics as having produced shrimp at one time or another. In 1984, only 29 countries had reported any shrimp production. The shrimp producing countries are found in all regions, including Europe and the Middle East. (Figure 3 and Table 1).

The following account details some of the salient features of shrimp aquaculture development in the major shrimp producing countries⁶.

Thailand has been the leading world producer of farmed shrimp from 1993 onwards. About 80.0 % of the shrimp farms are owned by small-scale farmers, operating 1-2 ponds, each ranging in size from 0.16 – 1.6 ha. The Government of Thailand provides considerable assistance to these farmers by developing sea water irrigation system (SIS) which brings in clean sea water that individual farms can tap. The SIS incorporates pre- and post-water treatment measures and a good system of shrimp disease diagnosis and prevention is made available to the shrimp farmers. Presently, extensive, semi-intensive and intensive types of farming systems are practiced in the country. Thailand has also demonstrated some of the most sustainable shrimp farming methodologies and the shrimp farms under Kung Krabaen Bay Royal Development Study Centre in Chanthaburi Province are excellent examples for replication.

⁶ Yap. W.G. 2000. Shrimp culture: A Global overview. Bay of Bengal News, Vol.II No.16: 5-12

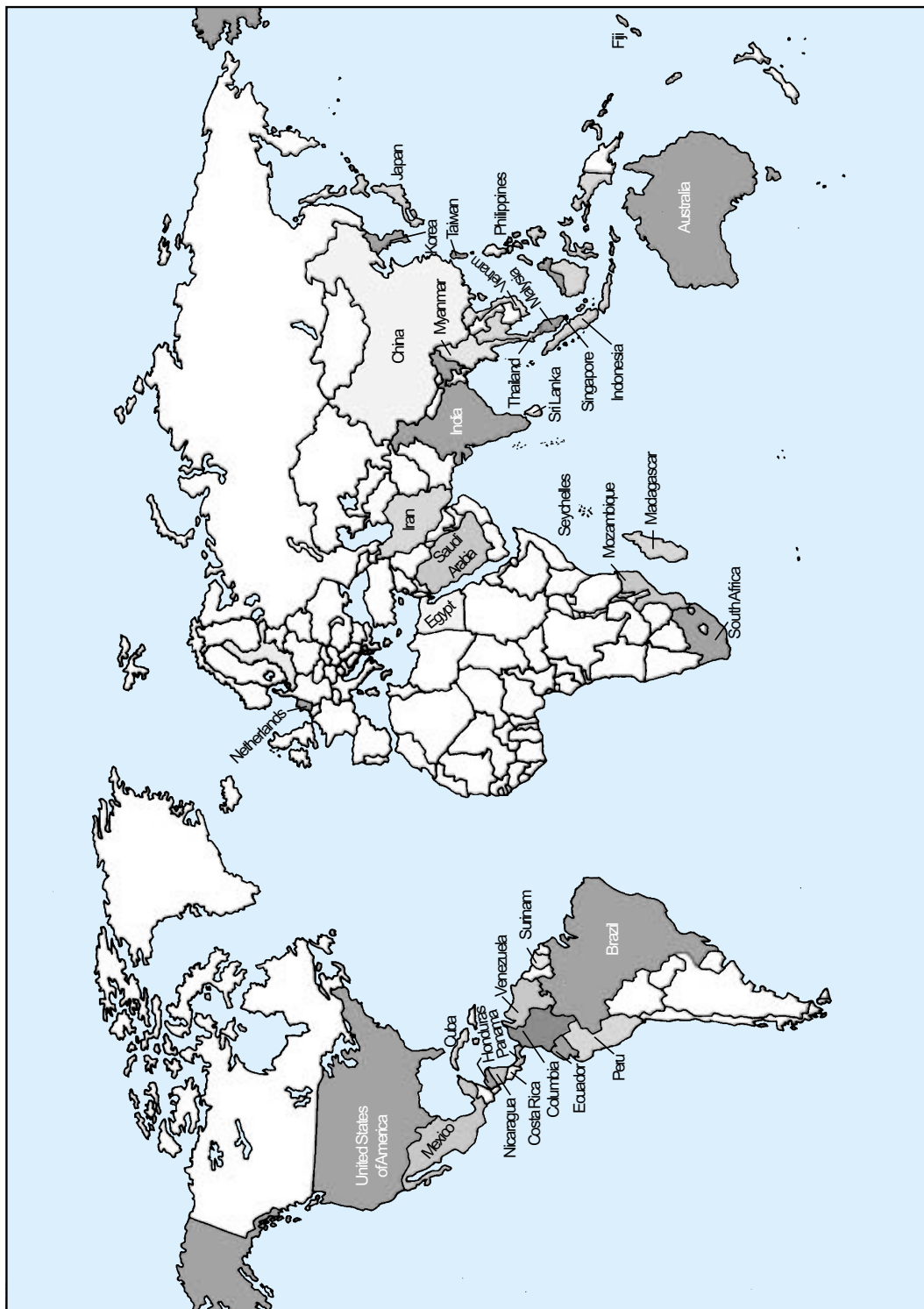


Figure 3. Major Shrimp Producing Countries in the World

Indonesia is the second largest shrimp producing country after Thailand. In the province of Lampung which is located in southern Sumatra, one of the world's largest shrimp farm under the control and management of one company can be found. Here the P.T. Dipasena Citra Darmaja has established 18 000 individual plastic-lined culture ponds covering some 4 500 ha in a 16 000 ha site. It has also obtained the rights to further develop at least 50 000 ha of land. Most of the ponds measure 2 500 m² gross area, with a few measuring half a hectare. As provided for under Indonesian law, any aquaculture development over 30 ha in Java and 50 ha in islands outside Java has to be developed under the *Tambak Inti Rakyat* (TIR) or nucleus-estate concept. Indonesia still has large undeveloped land in the outer islands, particularly in Sumatra and therefore has the potential to become the world's largest farmed shrimp producer, if the farming practices are done in a sustainable and responsible manner.

Table 1. Shrimp Aquaculture Production in Eastern and Western Hemispheres

Country	Production Heads-on (t)	Growout area (ha)	Average production (kg/ha)	Estimated number of hatcheries	Estimated number of farms
EASTERN HEMISPHERE (EH)					
Thailand	150 000	70 000	2 134	1 000	25 000
China	80 000	160 000	500	1 500	8 000
Indonesia	80 000	350 000	229	400	60 000
India	40 000	100 000	400	200	100 000
Bangladesh	34 000	140 000	243	45	32 000
Vietnam	30 000	200 000	150	900	8 000
Taiwan	14 000	4 500	3 111	200	2 500
Philippines	10 000	20 000	500	90	2 000
Malaysia	6 000	2 500	2 400	60	800
Australia	1 600	480	3 333	12	35
Sri Lanka	1 200	1 000	1 200	40	800
Japan	1 200	300	4 000	100	135
Other countries	14 000	20 000	700	30	2 000
EH TOTAL	462 000	1 068 780	1 455	4 577	241 270
Average global %	70%	82%		91%	99%
WESTERN HEMISPHERE (WH)					
Ecuador	130 000	180 000	722	350	1 800
Mexico	16 000	20 000	800	23	220
Honduras	12 000	14 000	857	13	90
Columbia	10 000	2 800	3 571	15	20
Panama	7 500	5 500	1 364	10	40
Peru	6 000	3 200	1 875	3	45
Brazil	4 000	4 000	1 000	18	100
Nicaragua	4 000	5 000	800	4	25
Venezuela	3 000	1 000	3 000	5	8
Belize	2 500	700	3 571	1	7
United States	1 200	400	3 000	8	20
Other countries	2 000	2 000	1 000	5	15
WH Total	198 200	238 600	1 797	455	2 390
Average Global %	30%	18%		9%	1%

Source: Jory, D. (1998). *World Shrimp Farming in 1997. Aquaculture Magazine Buyer's Guide*, 27:32-41

China, originally started with freshwater aquaculture but has now moved to coastal salt water aquaculture in a big way. The Chinese government took a macro-approach to development. Without the shrimp farms the coastal flat lands were useless for anything else. The meteoric rise in the Chinese shrimp farming was made possible by a massive development programme along the Bohai Bay coastline in the north east all the way down to Fujian in the south. Every year, thousands of hectares were developed by the Chinese government when it came to the realisation that shrimp farming was the best way of productive utilisation of vast tracts of arid saline-alkaline coastal flat lands, providing employment and earning foreign exchange. In 1993, China found that overstocking and lack of provision for treating wastewater discharge resulted in decline in production. However, mitigation measures were soon adopted and presently extensive, semi-intensive and intensive farming methods are practiced for shrimp farming.

Unlike other South-East Asian countries, Philippines lacks the abundance of resources suitable for shrimp aquaculture. At its peak in 1993, Philippines produced 95 816 metric tonnes of all species, but mostly of the giant tiger shrimp. The total production in 1997 fell largely due to shrimp disease. However, shrimp growers in Negros Occidental which used to be the centre of intensive shrimp farming are slowly trying out lower densities, using pro-biotics, pond bio-remediation techniques and even mixed culture with fish species such as tilapia. The South-East Asian Fisheries Development Centre (SEAFDEC), an inter-governmental organization with headquarters in Bangkok is providing technical back-up to shrimp farmers in the Philippines for making farming practices more sustainable.

Vietnamese shrimp production has steadily increased to a ten-fold growth over 12 years. The farms are extensive and semi-intensive types.

Bangladesh is slowly increasing its production year by year and it already produces more than the Philippines. The culture systems used are extensive, semi-intensive and intensive.

The Middle East, is also striving to become a shrimp producing region. Many of the countries in the region including UAE, Kuwait and Yemen have initiated moves to venture into shrimp farming. So far, large-scale developments have taken place only in two countries, Saudi Arabia along the Red Sea and Islamic Republic of Iran along the Persian Gulf. Iran is moving very fast after culture trials under a UNDP/FAO Project showed that it is possible to breed and grow local species found in the Persian Gulf which has an average salinity of 38 ppt. Initially two species were being farmed– *P. semisulcatus* and *P. indicus*. However, due to slow growth of the former when farmers shifted to a locally milled feed, all the farms are now stocked with *P. indicus*. In the year 2000, shrimp farming expanded even faster than it did in 1999. Over 12 000 ha of new farms are being designed and built in the coastal areas. Presently, the harvest average 1.8 metric tonnes per hectare and almost the entire crop is exported to Europe.

Ecuador, the only country outside Asia, stands fourth position in production. As early as 1984 it was already producing more than any of the major shrimp producing countries in Asia. The production touched a peak of about 130 000 metric tonnes in 1997. Extensive, and semi-intensive methods of culture are practiced in Ecuador. Practically all the Latin American countries from Mexico to Peru produce shrimp. However, except for Mexico, Honduras and Columbia which in 1997 produced 16 000, 12 000 and 10 000 metric tonnes respectively, all the rest produced less than 10 000 metric tonnes.

3.3 Development of Shrimp Aquaculture in India

India, by virtue of its 8 118 km long coastline, 2.02 million sq. km of Exclusive Economic Zone (EEZ) and extensive geographical stretch with varied terrain and climate, supports a wide diversity of inland and coastal wetland habitats. It has been estimated that there is 3.9 million ha of estuaries and 3.5 million ha of brackishwater areas in the country⁷. Out of this, 1.2 million ha of coastal area has been identified as suitable for brackishwater aquaculture and through the use of sustainable practices this resource can yield optimum quantities of shrimp and other commercially valuable fin and shell fish species.

⁷ WWF. 1992. India's Wetlands, Mangroves and Coral Reefs. Prepared by World Wild Fund For Nature, India for the Ministry of Environment and Forests.

Figure 4. India – Coastal States and Union Territories



The shrimp farming areas are mainly located in the coastal states of Andhra Pradesh, West Bengal, Kerala, Orissa, Tamil Nadu, Karnataka, Maharashtra, Gujarat and Goa (Figure 4). The major markets for Indian shrimp are Japan, Western Europe and USA. Today, India stands amongst the major shrimp producing countries having a growth rate of about 300.0 % over the last decade.

In India, shrimp farming has been traditionally practiced in the coastal states of West Bengal and Kerala. The traditional *trap and culture* system was characterized with low production levels of mixed species of fin and shell fishes. The importance of introducing scientific farming techniques to increase production and productivity from the traditional system was felt and the Indian Council of Agricultural Research (ICAR) implemented an All India Coordinated Research Project on Brackishwater Fish Farming (1973- 1984) to develop and test various farming technologies under different agro-climatic conditions of the country. The main centre of the project was located in West Bengal and the other centres were located in Orissa, Andhra Pradesh, Tamil Nadu, Kerala and Goa for demonstrating the technologies to the small-scale farmers.

Simultaneously, the shrimp hatchery technology was also introduced into the country and two commercial hatcheries were established in the late eighties with the initiative from the MPEDA. With the establishment of more hatcheries in the private sector, the country witnessed a faster development of shrimp farming between 1990 – 1994. The culture practice was also gradually intensified and varied levels of intensification were noticed depending on the investment capabilities of the farmer/ entrepreneur. Stocking densities of 2 to 30 nos/ m² were used under different systems by the farmers.

Like any other agriculture/ animal husbandry practice, shrimp culture was also affected by health and disease problems. Initially, some of the bacterial diseases were noticed which were more or less localized and the mortality levels were not very high. Later in 1995, viral diseases such as *monodon baculo virus* and *white spot virus disease* affected the farmed shrimp and there was a slump in shrimp farming. Reasons such as heavy stocking densities and poor farm management practices were attributed to the shrimp diseases outbreak in the country. Following the verdict of this Court and the establishment of Aquaculture Authority with powers to issue licenses and guidelines, the shrimp culture sector is gradually going through a regulated regime and is slowly returning to its normal production level.

3.4 Development of Allied Activities

3.4.1 Shrimp Hatcheries

Success of any farming activity is dependent on the availability of quality seed in required quantity. As the demand for shrimp seed increased with the development of commercial shrimp farming, a number of commercial shrimp hatcheries have also been established. Most of these hatcheries have state-of-the-art facilities for producing healthy and disease free post-larvae. The details of the state-wise distribution of shrimp hatcheries are presented in Table 2.

Presently, there are 260 shrimp hatcheries in operation in the country with a total annual production capacity of 10.8 billion shrimp seed (PL20). These hatcheries are mostly located in the east-coast states, with the maximum number (133) in Andhra Pradesh followed by 72 in Tamil Nadu. Location of the large number of hatcheries on the east coast is also because of the greater availability of brood shrimp in the Bay of Bengal as compared to the Arabian Sea.

3.4.2 Feed Mills

Shrimp feed production is one of the allied activity which is associated with the sustainable development of shrimp farming in the country. At present there are 33 shrimp feed mills with a total installed capacity of 150 000 metric tonnes (Table 3)⁸. Andhra Pradesh with 24 mills and Tamil Nadu with three mills together contribute to about 87.0 % of the total feed production capacity.

Table 2. Shrimp Hatcheries in India

State	Number of shrimp hatcheries	Annual Production level (in millions)
West Bengal	3*	-
Orissa	9	445
Andhra Pradesh	133	6 909
Tamil Nadu	72	2 933
Kerala	24*	248
Karnataka	12*	240
Maharashtra	6*	51
Gujarat	1	5
Total	260	10 831

Source: State-wise inventory of Aqua hatcheries.2000. *Fishing Chimes*, 19 (10 & 11): 164 – 214

* Modified according to MPEDA, 2001

Table 3. State-wise Details of Shrimp Feed Production in India⁸

State	No. of feed mills	Installed capacity (MT)
Kerala	2	12 000
Karnataka	3	1 000
West Bengal	1	6 000
Andhra Pradesh	24	110 500
Tamil Nadu	3	20 500
Total	33	150 000

3.4.3 Post-harvest Infrastructure Facilities and Exporters

The development of shrimp farming and the increased production from aquaculture has led to an increase in the quantum of exports. To cope with the increased load and meet the requirements of the importing countries and the growing domestic market on product quality, there has been a general increase in the post-harvest infrastructure for the seafood processing and exports. The details of the infrastructure facilities as on 31.3.1990 and 31.3.2000 are given in Table 4 below⁹.

Table 4. Details of Infrastructure Facilities Available for Shrimp Processing

Category	Number (as on 31.3.1990)	Capacity (t)	Number (as on 31.3.2000)	Capacity (t)
Freezing plant	231	2 296	394	8 439
Ice plant	132	1 854	157	2 970
Cold storage	304	42 458	479	105 991
Exporters	864	-	1 549	-

Source: MPEDA, 2001

⁸ MPEDA, March 2001

⁹ MPEDA, March 2001

3.5 Status of Shrimp Aquaculture in the Coastal States and Union Territories

Starting in a small way in the late 1980s, commercial shrimp aquaculture became a significant activity in the early 1990s in selected pockets along the country's vast coastline. The states with the highest concentration of shrimp culture farms are Andhra Pradesh, Tamil Nadu and Orissa. Some of the west-coast states like Maharashtra and Goa also developed commercial shrimp farms, but the overall area is much less as compared to the states on the east coast. The area and production under traditional systems was stagnant for decades as there was no effort made for optimisation of the production through adoption of scientific methodologies.

Commercial shrimp farming developed on account of the government's policy to promote shrimp culture in view of its potential to utilise the vast saline tracts along the coastline, provide employment opportunities to coastal rural population and to earn valuable foreign exchange. After the liberalization of Indian economy in 1991, development of shrimp culture gained greater momentum. Individual entrepreneurs were also encouraged to take up shrimp farming with both financial and technical support.

The opposition to shrimp culture has stemmed from both socio-economic and environmental issues. The socio-economic issues include land alienation, displacement of coastal communities from open access to public lands used by them for fish and net drying, grazing, etc. The environmental issues include salinisation of groundwater and productive agricultural lands, contamination of ground and surface waters with organic wastes of shrimp farming, destruction of mangroves, loss of mud-flats which result in changes in conditions mitigating/controlling floods.

3.5.1 Gujarat

Gujarat is the northern-most maritime state on the west coast of India with a long coastline of 1 600 km and salt marshes, sand-belts and gravel patches mark the coastal topography (Figure 5). The southern coast of the Gulf of Kutch is characterised by innumerable coral reefs, tidal mud flats and coral islands. The Rann of Kutch is a vast expanse of tidal mud flats flaked with saline efflorescence.

The Gujarat coast, including the two Gulfs, is blessed with physical features congenial to the development of fisheries and aquaculture. The area of the continental shelf of Gujarat is estimated at 184 000 sq. km and it is about 34.0 % of the total shelf area of India. The maximum width of the continental shelf is 191 miles due west off Umbergoan (Valsad district) and minimum width is 58 miles between Madhavpur and Miyani (Porbandar district). It is estimated that out of 2.02 million sq km of the EEZ available to the country, the west coast accounts for 860 000 sq. km. The EEZ off Gujarat coast is estimated at 214 060 sq. km.

Gujarat with 376 000 ha of potential brackishwater land, occupies the second place among the maritime states next to West Bengal. However, only 997 ha have been developed for farming till 1997-1998. Out of the developed area, only 316 ha were in operation during 1998 – 1999 (Figure 6). The low rate of development in the state is due to the delay in developing lease policy and allotment of land to the different sectors by the state government.

3.5.2 Daman and Diu

The Union Territory of Daman & Diu is situated on the west coast of India (Figure 7). Daman is bordered by Maharashtra in the south and Gujarat in the north and east. Diu is the southern-most point of the Kathiawar Peninsula, Gujarat. Daman & Diu have a coastline of 27 km. Shrimp farming has not been taken up in this Union Territory due to lack of suitable areas along the small coastline.

Figure 5. Coastal Districts of Gujarat

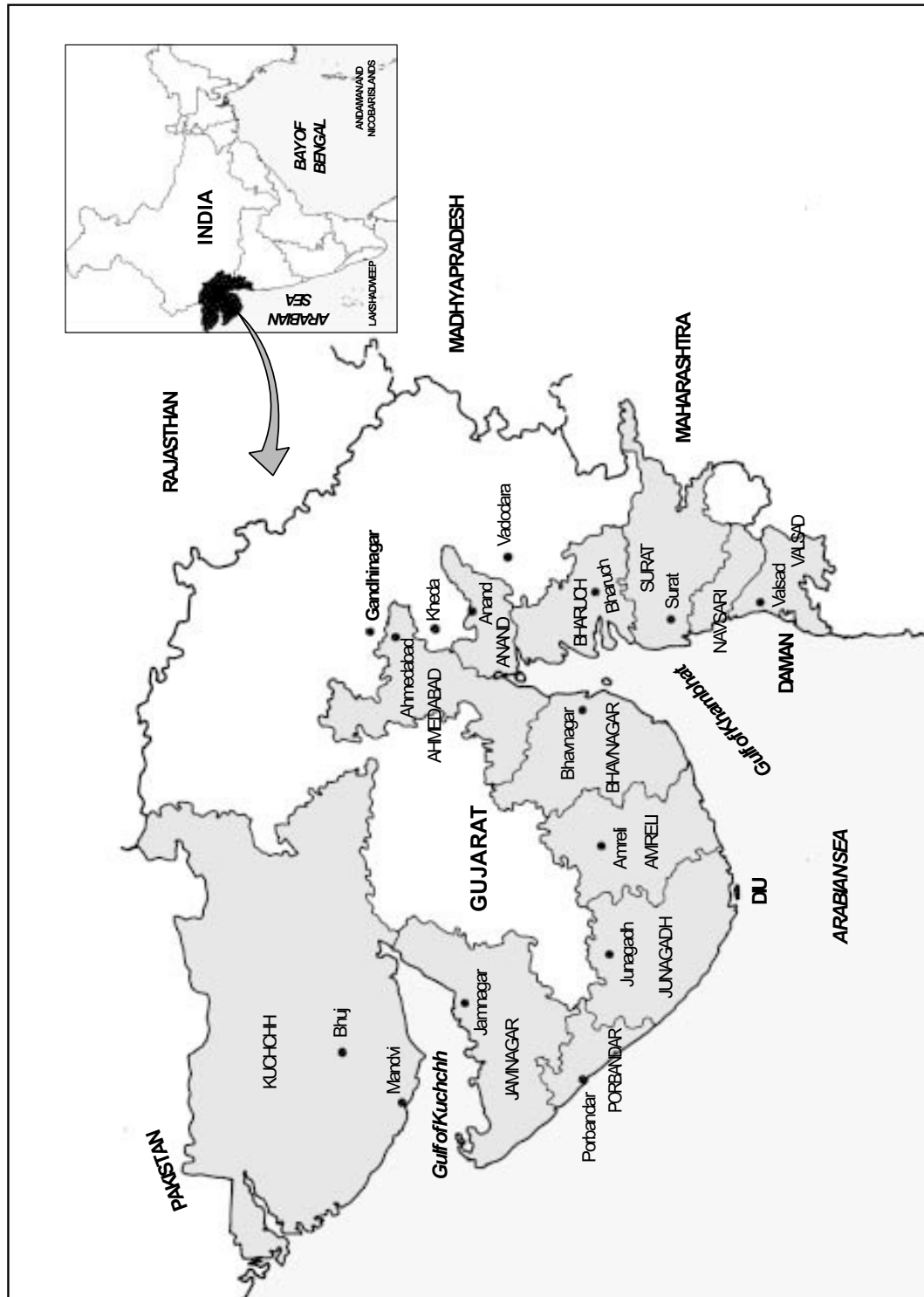
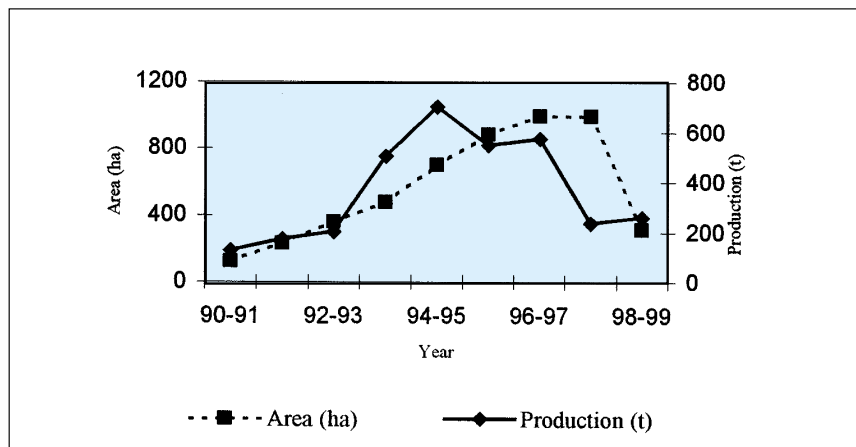


Figure 6. Gujarat : Area under Shrimp Farming and Total Production

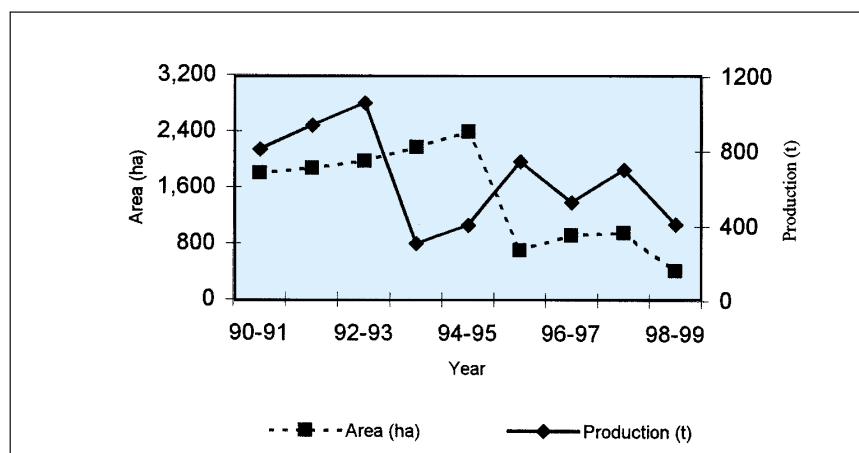


3.5.3 Maharashtra

Maharashtra, the third largest state in the country, in terms of area and population, appears as a huge irregular triangle with its base on the western coast of the country facing the Arabian Sea (Figure 8). The state has a coastline of 720 km and continental shelf area of over 0.11 million sq. km which offers rich resources for marine fish production. The state is endowed with rich fish and crustacean fauna comprising pomfrets, prawns, Bombay duck, mackerel and ribbon fish, which are exportable varieties.

Maharashtra occupies the fourth place among the maritime states with about 80 000 ha of potential brackishwater area for shrimp farming. Out of this, only about 2 400 ha have been developed for shrimp farming till 1994-1995. However in 1998 - 1999, the total area under shrimp farming got reduced to 426 ha (Figure 9)¹⁰. The average production levels during 1993-1995 have touched a very low level of 125 to 160 kg/ ha. As per the information provided by the government of Maharashtra, a total of 90 farms with 712.4 ha area is presently under shrimp farming. All these farms are creek-based and 66 farms are within CRZ and the remaining 24 farms are outside CRZ. Farm-wise area coverage has been estimated as farms with < 2.0 ha – 5.0 %; 2.0 - 5.0 ha – 20%; 5.0 –40 ha 31 %; > 40 ha – 44 %¹¹.

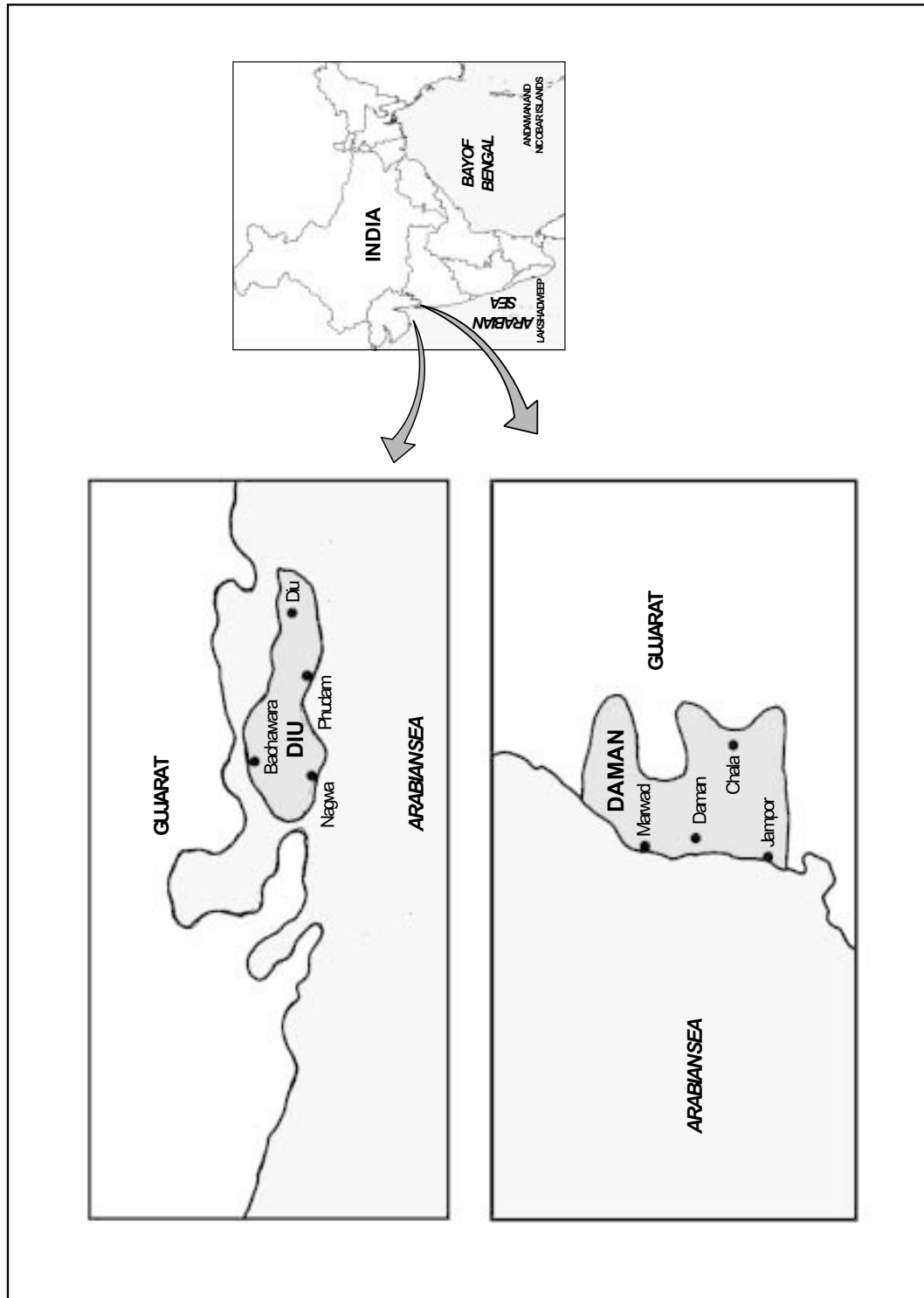
Figure 9. Maharashtra : Area under Shrimp Farming and Total Production



¹⁰ MPEDA, 2000

¹¹ Government of Maharashtra, March, 2001

Figure 7. Diu & Daman



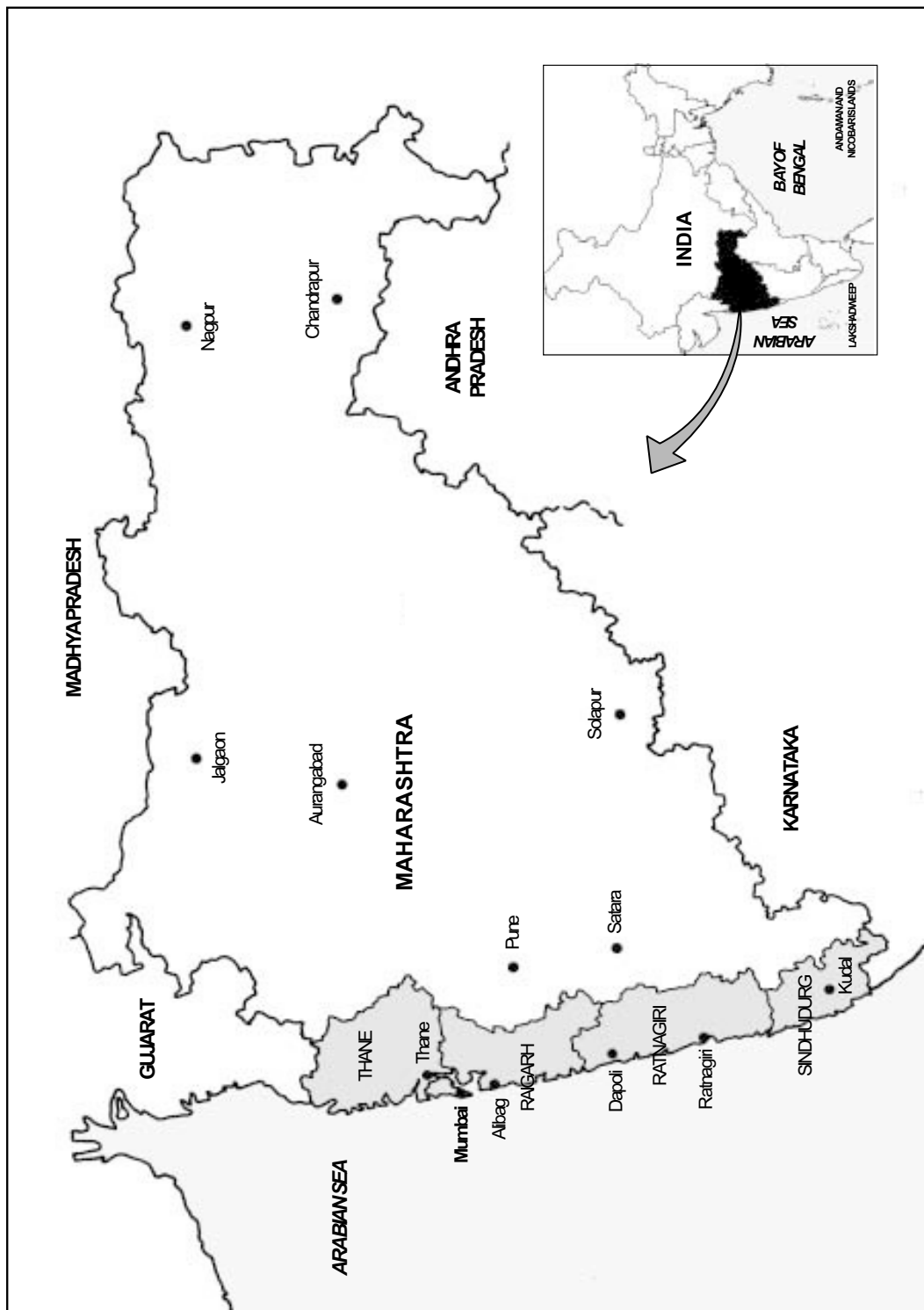


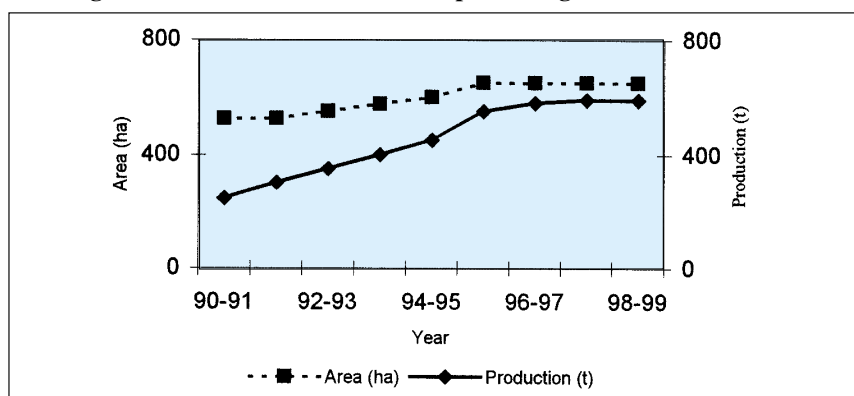
Figure 8. Coastal Districts of Maharashtra

3.5.4 Goa

Goa, with a coastline of 104 kms and around 250 kms of inland waterways and 4 000 hectares of marshy land along the estuaries, holds a vast potential for development of fisheries and coastal aquaculture (Figure 10). Among the marine catches, there are 41 varieties of fish species, the prominent being mackerel and sardines, which form almost 46.0 % of the total catch. The other popular varieties are catfish, kingfish and pomfrets. The commercial varieties also include shrimps, squids, cuttlefish, breams and ribbon fish.

A total of 18 500 ha of potential brackishwater farming area is available in the state. Around 500 ha of brackishwater area is under traditional farming (Figure 11)¹². Shrimp farming in *Khazan* lands is generally

Figure 11. Goa : Area under Shrimp Farming and Total Production



practiced during December to April after the paddy harvest. However, development of improved traditional farming in the state is very slow with only 110 ha area comprising 48 farms being developed so far. It is estimated that 33.0 % of the total farm area comprises farms under 2.0 ha size; 33.0% within 2.0 – 5.0 ha and 34.0 % above 5.0 ha. All the 48 farms are creek-based with 28 farms within CRZ and 20 farms outside CRZ¹³.

3.5.5 Karnataka

Karnataka, is located on the western edge of the Deccan plateau and is surrounded by Maharashtra and Goa on the north, Andhra Pradesh on the east, Tamil Nadu and Kerala on the south (Figure 12). On the western side of the state is Arabian Sea. Karnataka has a coastline of 300 km with a rich continental shelf of 27 000 sq. km and an EEZ of 87 000 sq. km with a resource potential of 0.425 million tonnes of fish production per annum. The present fish production of the state is around 0.290 million tonnes.

A total of 8 000 ha of potential brackishwater area is available in the state. In Karnataka, traditional shrimp farming is being carried out in 2 500 – 3 000 ha in *gazani* or *kharlands*. Shrimp culture is carried on after a crop of '*Kagga*', a salt resistant variety of paddy. The production of shrimp in the traditional farming is very meager and ranges between 50 – 150 kg/ ha. Presently, about 488 ha area is developed in the state under the improved traditional system of culture. It is estimated that 36.0 % of the total area is under farms of less than 2.0 ha size; 31.0% in farms between 2.0 – 5.0 ha and 33.0% in farms above 5.0 ha size¹⁴. The average production levels in the state is about 700 kg/ ha (Figure 13)¹⁵.

¹² MPEDA, 2000

¹³ Government of Goa, January, 2001

¹⁴ Government of Karnataka, February 2001

¹⁵ MPEDA, 2000

Figure 10. Goa

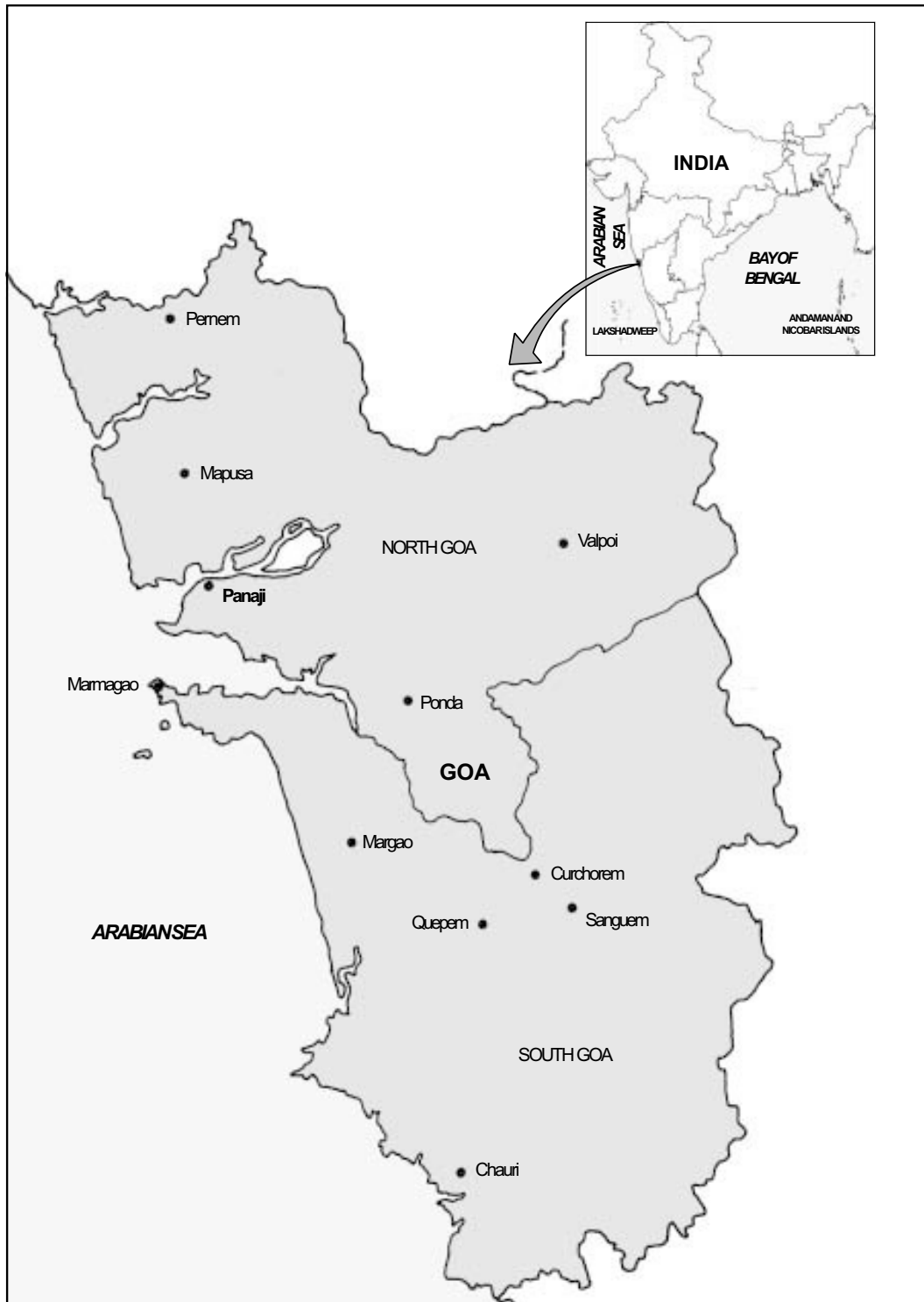


Figure 12. Coastal Districts of Karnataka

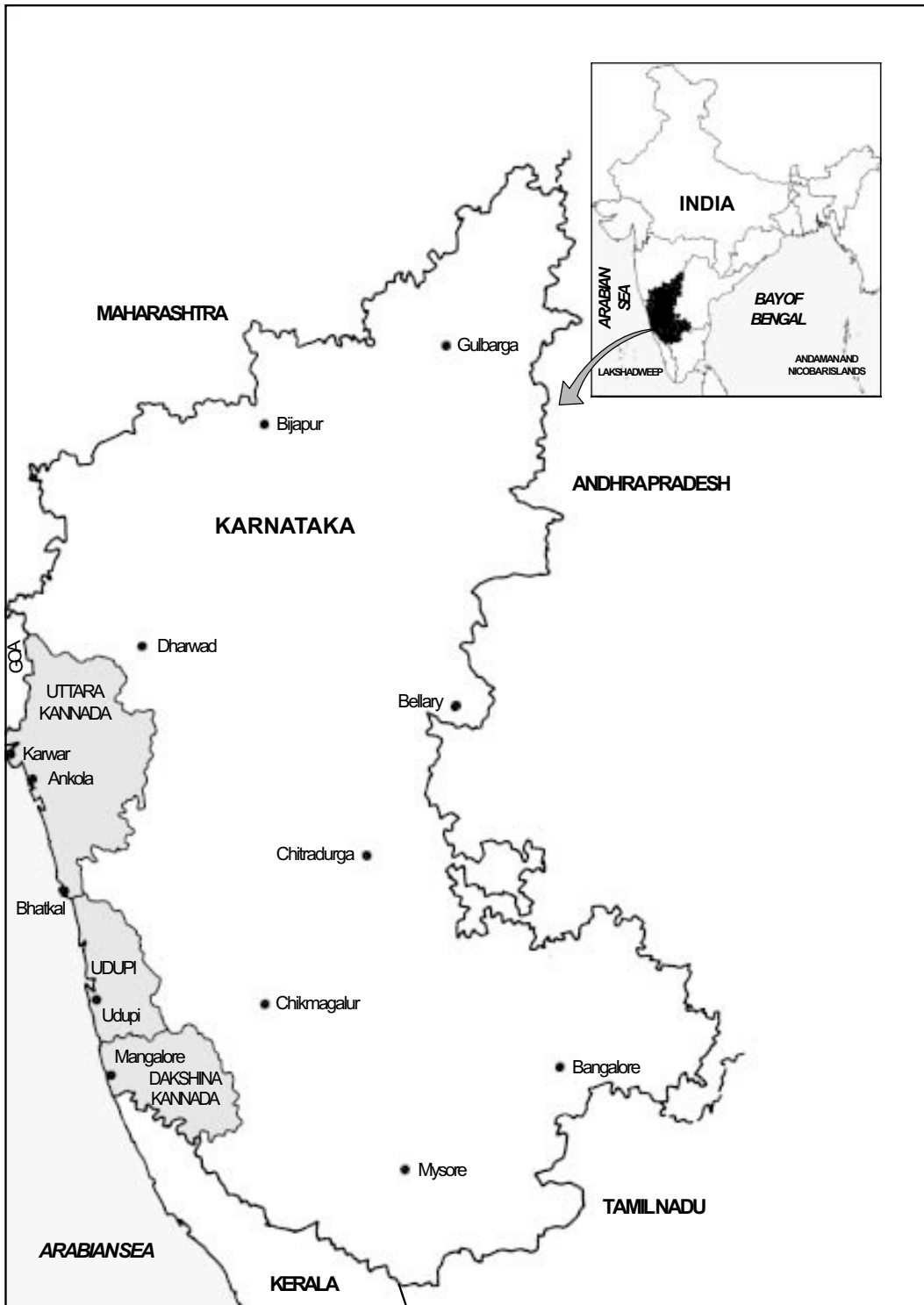
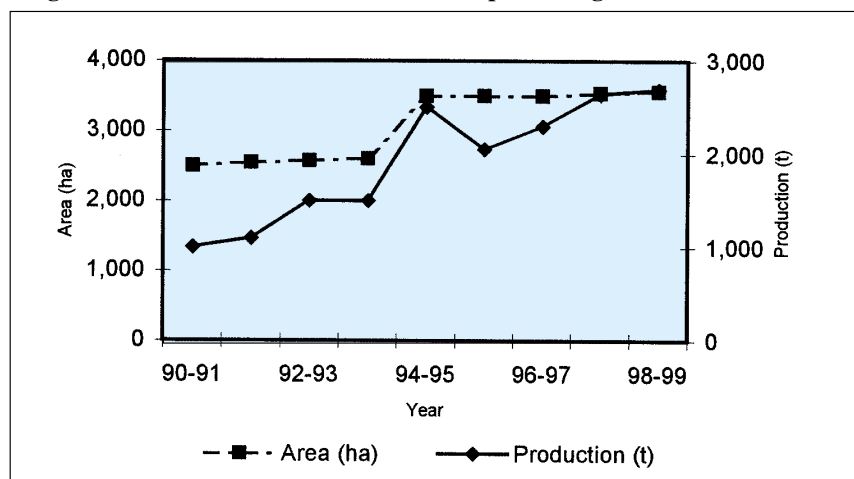


Figure 13. Karnataka : Area under Shrimp Farming and Total Production



3.5.6 Lakshadweep

Lakshadweep is the tiniest Union Territory of India and lies about 220 to 440 kms from Kochi, Kerala (Figure 14). It is an archipelago comprising 12 atolls, 3 reefs and 5 submerged banks, with an area of 32 sq. km. Lakshadweep has immense potential for development of marine fisheries. The islands have a lagoon area of about 4 000 sq. kms, territorial waters covering an area of 20 000 sq. kms, continental shelf of 4 000 sq. km, an EEZ of 0.7 million sq. km and a coastline of 132 km, which is approximately 1.6 % of the country's total coastline. The estimated marine fishery potential in the EEZ of Lakshadweep is about 63 000 tonnes consisting mainly of tuna and tuna like fishes, elasmobranches, perches, etc.

The coastal area of Lakshadweep is rich in coral reefs, marine life, mineral resources and an unrivalled wealth of ornamental fish species. The geological formation of the islands do not permit construction of ponds for shrimp culture. Excepting some trials on pearl culture, no aquaculture activity is presently developed in the islands.

3.5.7 Kerala

Kerala, situated on the south-western part of India has a coastline of 590 km and a continental shelf area of 40 000 sq. km within 200 m. depth (Figure 15). It has been estimated that the fisheries potential in this zone is about 0.8 million tonnes per annum. The total fish production of Kerala in 1998-1999 was 649 220 tonnes of which marine fish production accounted for 583 340 tonnes.

The state has a sprawling brackishwater area of nearly 65 000 ha suitable for shrimp farming. Out of this about 14 500 ha has been utilised for shrimp aquaculture (Figure 16). Major portion of this area is under the traditional *prawn filtration fields*, locally known as *Chemmeen kettu*. This culture operation is an age-old avocation, wherein shrimp culture and paddy cultivation is practiced in rotation during summer and monsoon seasons respectively. The average production level of shrimp in the state has come down from 850 kg/ ha in 1995 – 1996 to 520 kg/ ha in 1998-1999¹⁶. Selective/ supplemental stocking is also practiced in traditional culture systems with a view to increasing the production levels of the desirable species.

As per the estimates provided by the government of Kerala, 2 166 ha is presently under improved traditional system. Of this area, 36.0 % is under 2.0 ha; 18.0 % is under 2.0-5.0 ha and 46.0 % is under farms with area more than 5.0 ha¹⁷.

¹⁶ MPEDA, 2000

¹⁷ Government of Kerala, April 2001

Figure 14. Lakshadweep

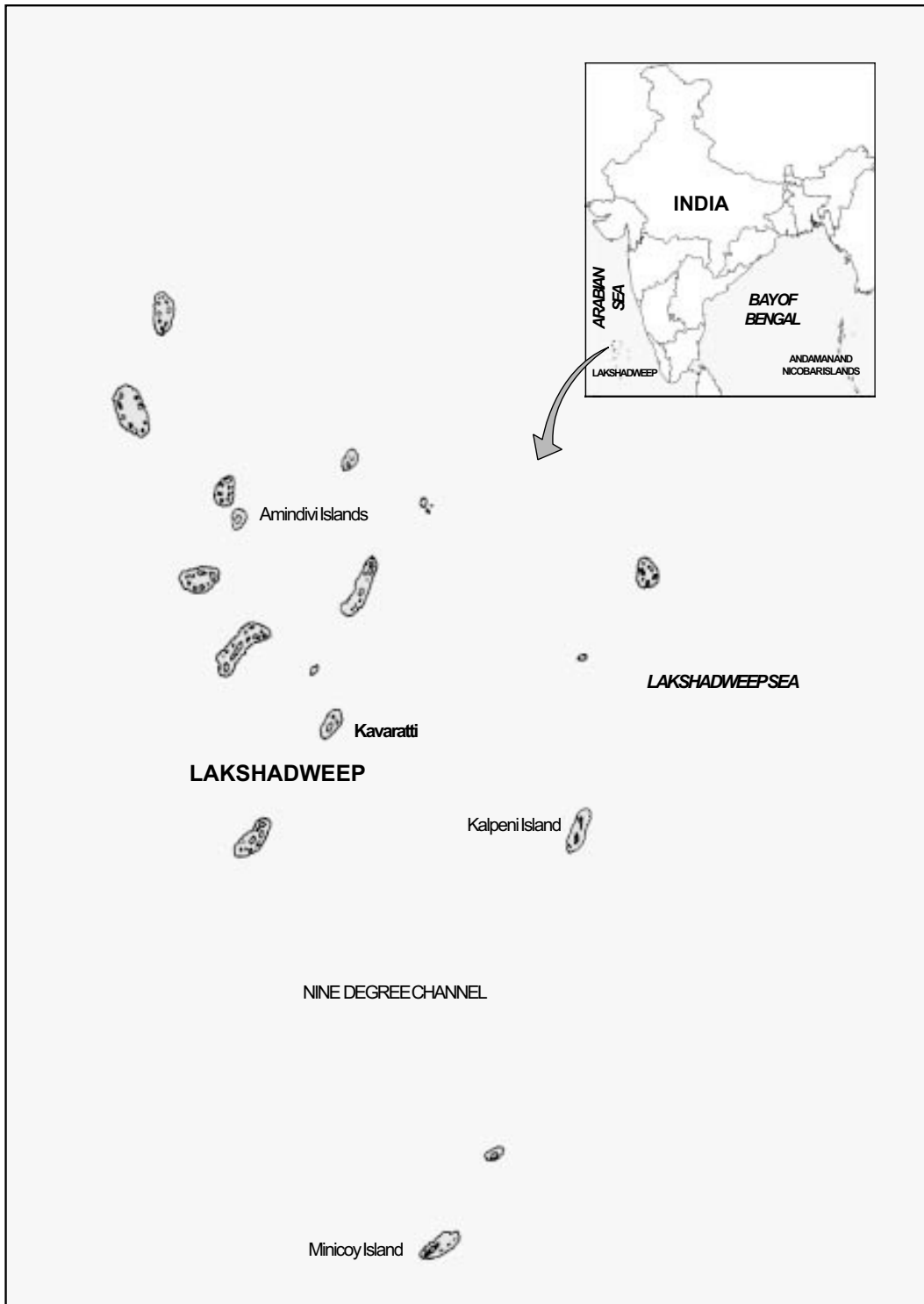
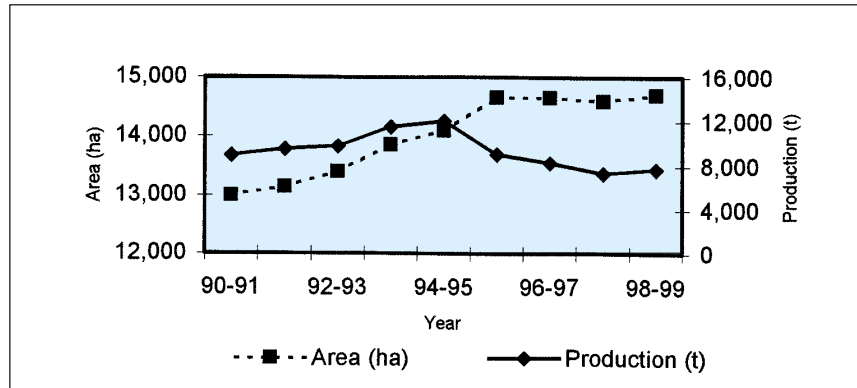


Figure 16. Kerala : Area under Shrimp Farming and Total Production



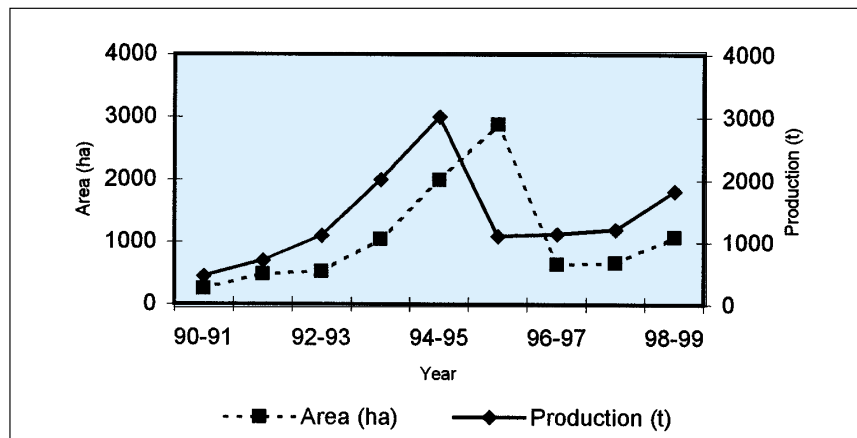
3.5.8 Tamil Nadu

With an area of 130 058 sq. km, Tamil Nadu is situated on the south-eastern side of the Indian peninsula. The state is bounded on the east by the Bay of Bengal, in the south by the Indian Ocean, in the west by the states of Kerala and Karnataka and the north by Karnataka and Andhra Pradesh (Figure 17). Tamil Nadu is one of the nine maritime states of India endowed with the second longest coastline of 1 076 km. The continental shelf of Tamil Nadu (upto 100 fathom/200 meters depth) is narrow in most places varying from 4.0 to 6.0 km in width from the coast and covers an area of 41 412 km.

Tamil Nadu with a total of 56 000 ha of potential shrimp farming area ranks sixth among the maritime states of the country. Although a total of 4 455 ha has been developed¹⁸ in the state for shrimp farming, yet only a maximum of 2 879 ha has been reported in use for farming¹⁹. The average production rate reported during 1994-1995 was about 1 500 kg/ ha, which declined to 400 kg/ ha during 1995-1996 due to the outbreak of viral diseases. By 1998 – 1999, the production levels again recovered to 1 674 kg/ ha (Figure 18).

Of the total area developed in Tamil Nadu, farms covering 3 178 ha are creek-based and the remaining 1 277 ha are sea-based. About 3 268 ha of the developed area is within the CRZ while 1 187 ha is outside CRZ²⁰.

Figure 18. Tamil Nadu : Area under Shrimp Farming and Total Production



¹⁸ Government of Tamil Nadu, March 2001

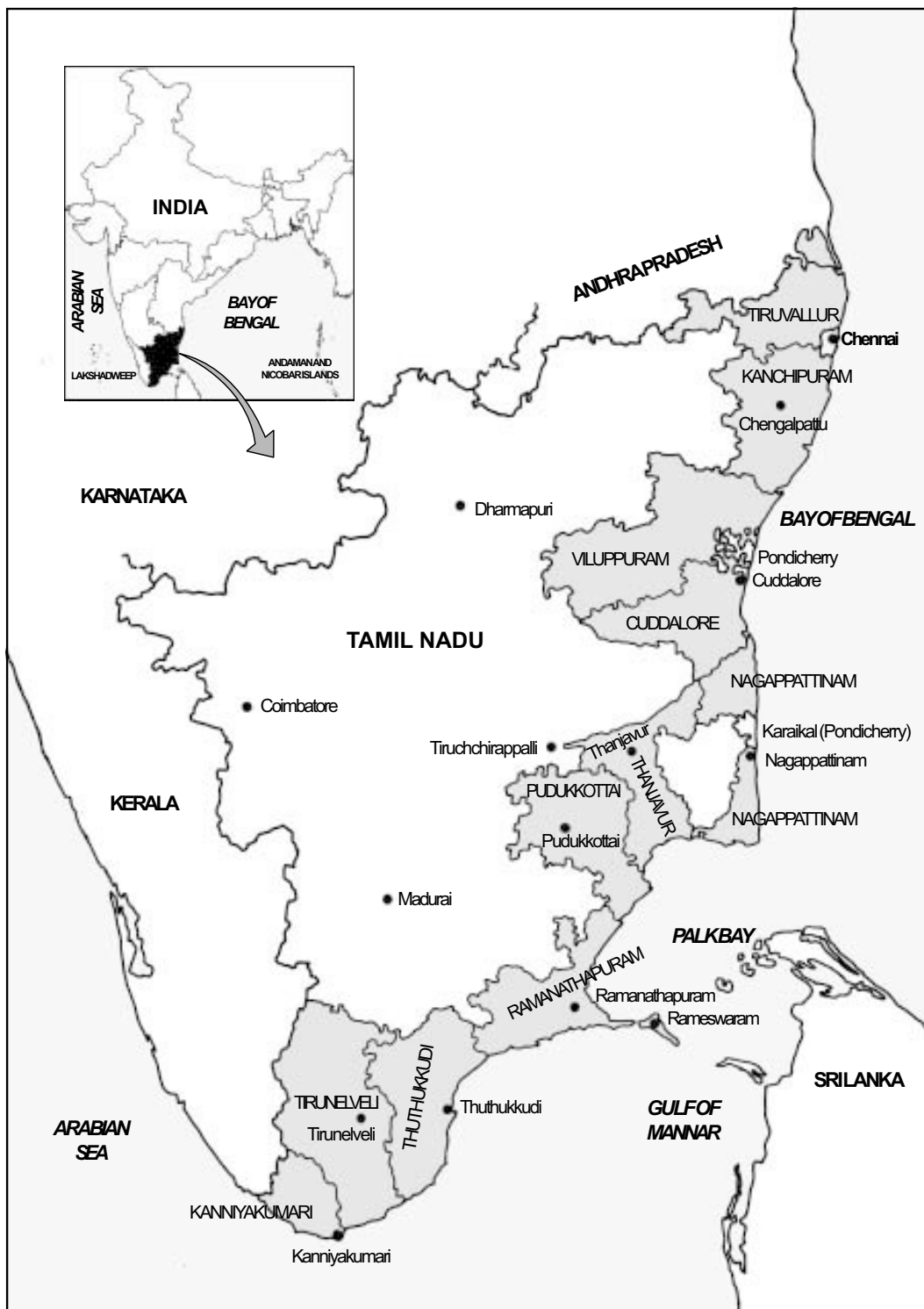
¹⁹ MPEDA, 2000

²⁰ Government of Tamil Nadu, March 2001

Figure 15. Coastal Districts of Kerala



Figure 17. Coastal Districts of Tamil Nadu

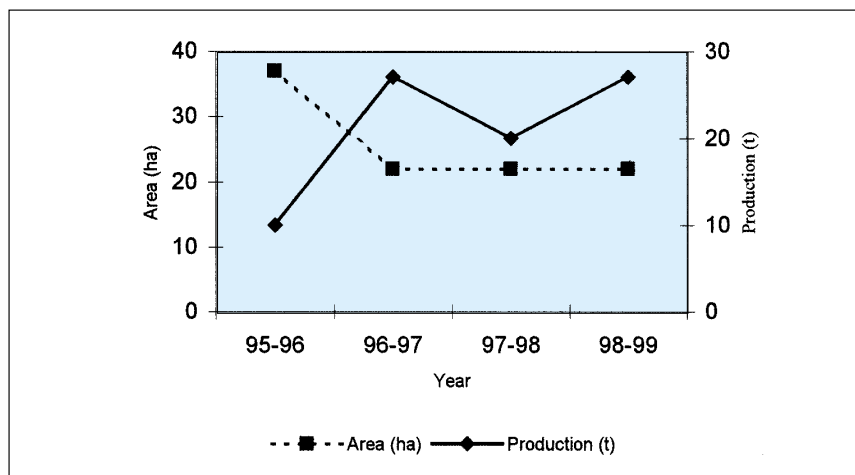


3.5.9 Pondicherry

The Union Territory of Pondicherry covers an area of 492 sq. km and consists of four regions – Pondicherry, Karaikal, Mahe and Yanam (Figure 19). While Pondicherry, Karaikal and Yanam are situated on the Coromandel coast, Mahe is situated on the Malabar coast. Pondicherry has a coastline of 45 km which is rich in marine fisheries resources. The total fish production of Pondicherry for 1998-1999 was 42 700 tonnes. Of this, 38 600 (84.31 %) tonnes was from marine sector alone.

About 155 ha of shrimp farms have been developed from the available potential area of 800 ha. Of this area, 92.0 % are creek-based farms. Further 15.0 % of the farms are small with less than 2.0 ha farm holding; 41.0 % within 2.0 - 5.0 ha holding; and 44.0 % having holdings larger than 5.0 ha. All the farms have been developed outside the CRZ²¹. It is further reported that presently about 15-20 % of the total farm area is only under operation²² (Figure 20).

Figure 20. Pondicherry : Area under Shrimp Farming and Total Production



3.5.10 Andaman and Nicobar Islands

Andaman and Nicobar group of islands comprise more than 3 000 islands, of which a majority are uninhabited being too small or with no water. The important islands in the Andaman group are Land Fall Island, North Andaman, Middle Andaman and South Andaman (Figure 21). The Union Territory has a coastline of 1 912 km with 37 916 ha of marshy low lying area and mangrove swamps, about 35 000 sq. km of continental shelf and an EEZ covering an area of 0.6 million sq. km. These islands are blessed with enormous fishery potential, both in terms of resources and quantity. The estimated marine fish potential of the islands is about 0.24 million tonnes and the present catch is only 28 000 tonnes annually, which is about 10.0 % of the estimated potential.

The major constraint for developing shrimp farming in the Islands is the acid sulphate content in the soil. So far only experimental culture has been taken up by the Department of Ocean Development (DOD) in collaboration with MPEDA yielding production levels of 2 000 kg/ ha. The non-availability of seed and feed and transportation and marketing are the other constraints restricting shrimp farming in the Islands.

²¹ Government of Pondicherry, January 2001

²² MPEDA, 2000

Figure 19. Pondicherry

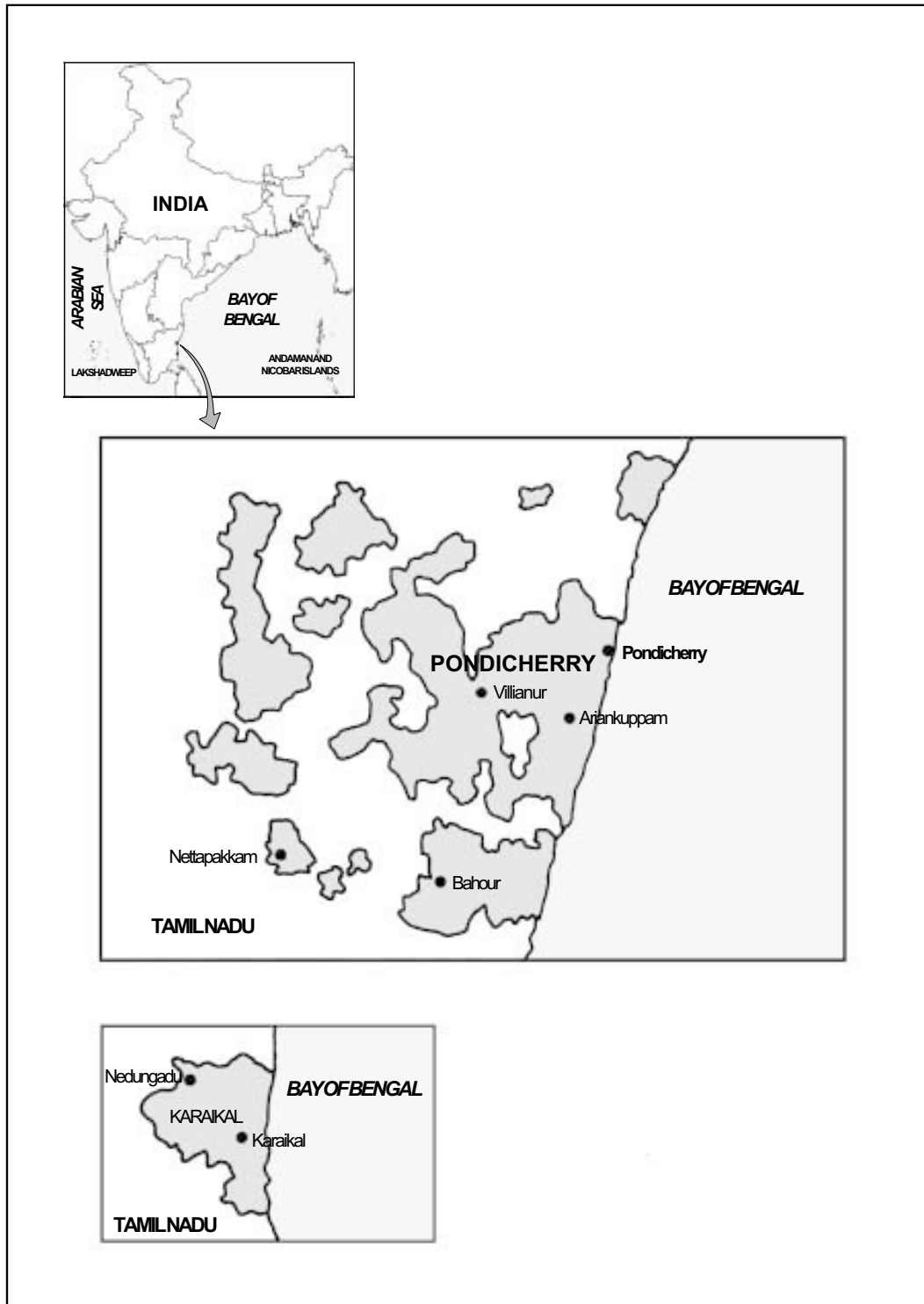
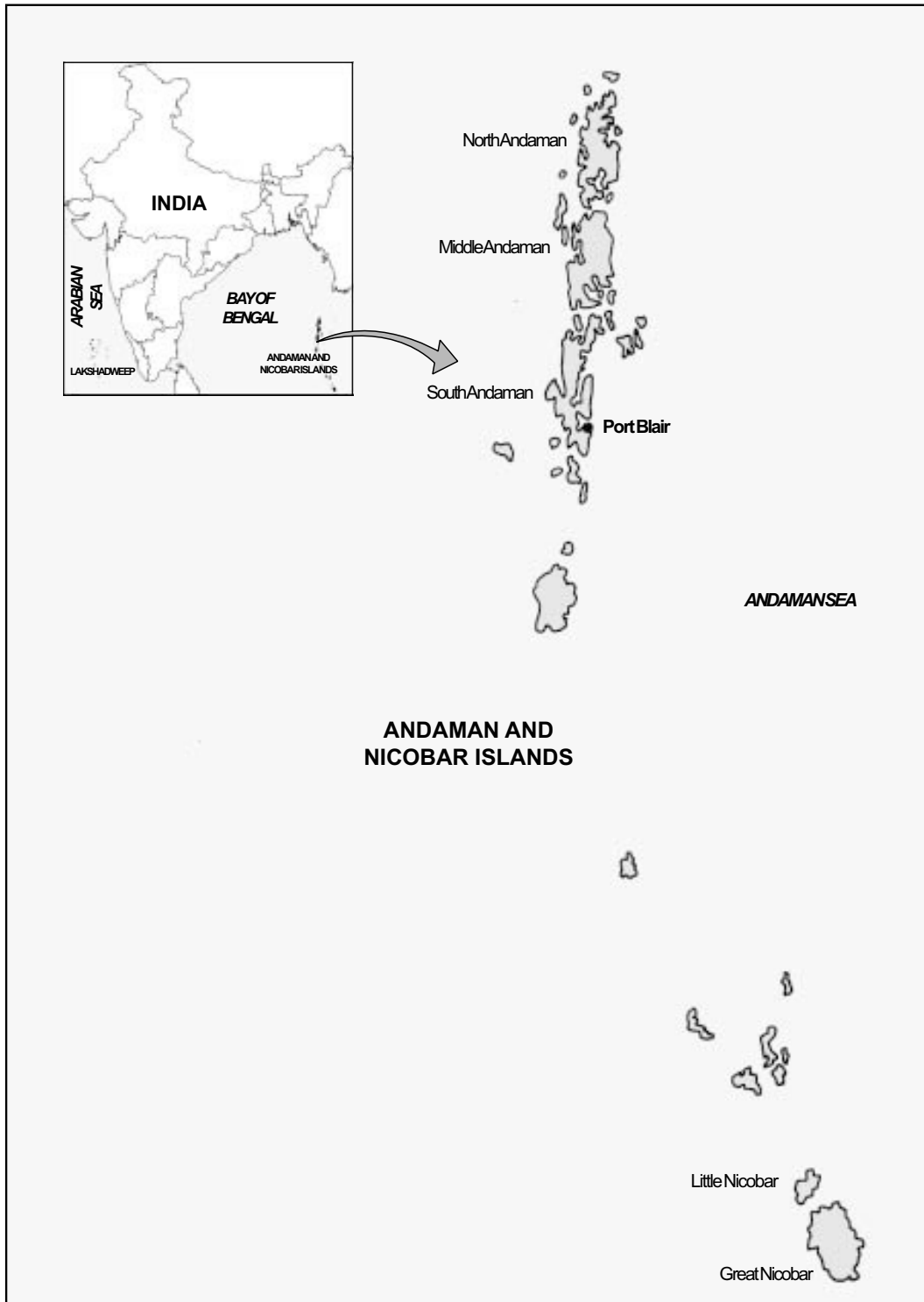


Figure 21. Andaman & Nicobar Islands

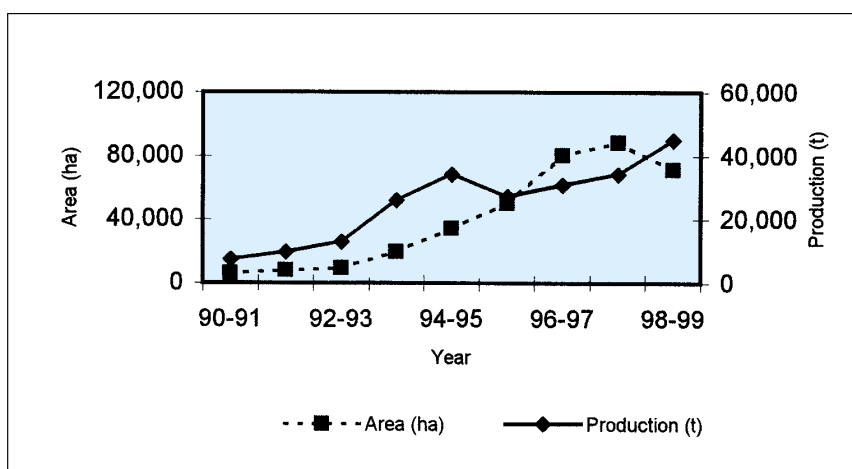


3.5.11 Andhra Pradesh

Andhra Pradesh occupies an area of 275 068 sq. km and has a coastline of 974 km (Figure 22). Andhra Pradesh is the largest maritime state of India and contributed 410 820 tonnes of fish during the year 1998-1999 of which marine fish production was estimated at 150 000 tonnes (36.5 %).

Growth of shrimp farming in Andhra Pradesh (Figure 23) was phenomenal during the years 1990-1996. In 1990, a total of 6 000 ha was under shrimp farming which has risen now to about 78 702 ha, accounting for more than 50.0 % of the available potential brackishwater area in the state. The average rate of production was above 1 000 kg/ ha during 1993-1994, which dropped to about 630 kg/ ha in 1998-1999²³. Out of the total 78 702 ha, 75 625 ha (96.0 %) is based on brackishwater/ estuarine creeks and 3 077 ha (4.0 %) is based on sea. It is estimated that about 79.0 % of the creek-based farms and 40.0 % of the sea-based farms are located beyond CRZ. Further 75.0 % of the total area is owned by small farmers with less than 2.0 ha farm holding (59 175 ha); 8.0 % of the area is in farm holdings of 2.0 – 5.0 ha (5 811 ha); 17.0 % in farms of larger than 5.0 ha²⁴.

Figure 23. Andhra Pradesh : Area under Shrimp Farming and Total Production



3.5.12 Orissa

Orissa lies in the east coast of India, surrounded by West Bengal on the north east, Bihar on the north, Andhra Pradesh on the south east, Madhya Pradesh on the west and Bay of Bengal on the east (Figure 24). The state has 480 km of coastline and 26 000 sq. km of continental shelf that spreads over six coastal districts- Balasore, Bhadrak, Kendrapara, Jagatsinghpur, Puri and Ganjam.

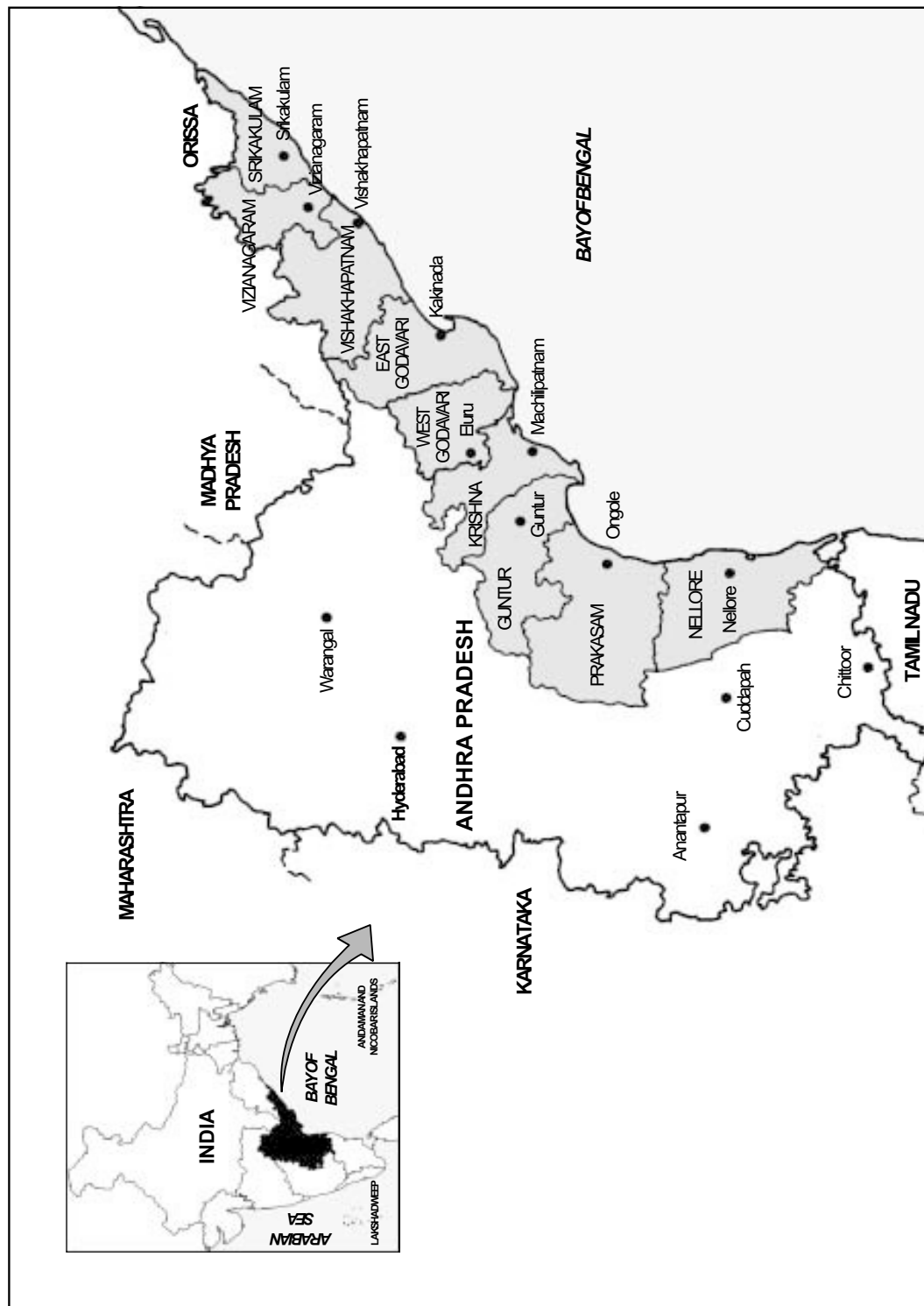
In Orissa, about 31 600 ha have been identified as potential area for brackishwater aquaculture out of which about 11 332 ha have been developed for shrimp farming by 1996-1997. But in 1998-1999 only 8 000 ha were in operation²⁵ (Figure 25). As per the government of Orissa, a total of 12 627 ha of farms are presently in operation in the state. About 45.0 % of the shrimp farming area is located on Chilka periphery. The remaining 55.0 % are creek-based and distributed in the 34 different estuary/ creek systems of the state. 30.0 % of the total area is under small farms of less than 2.0 ha (3 815 ha); 7.5 % of the area in farms of 2.0-5.0 ha size (941 ha); 57.0 % of the area in farms of above 5.0 ha size; and 5.5 % of the area is under corporate farms.

²³ MPEDA, 2000

²⁴ Government of Andhra Pradesh, January 2001

²⁵ MPEDA, 2000

Figure 22. Coastal Districts of Andhra Pradesh



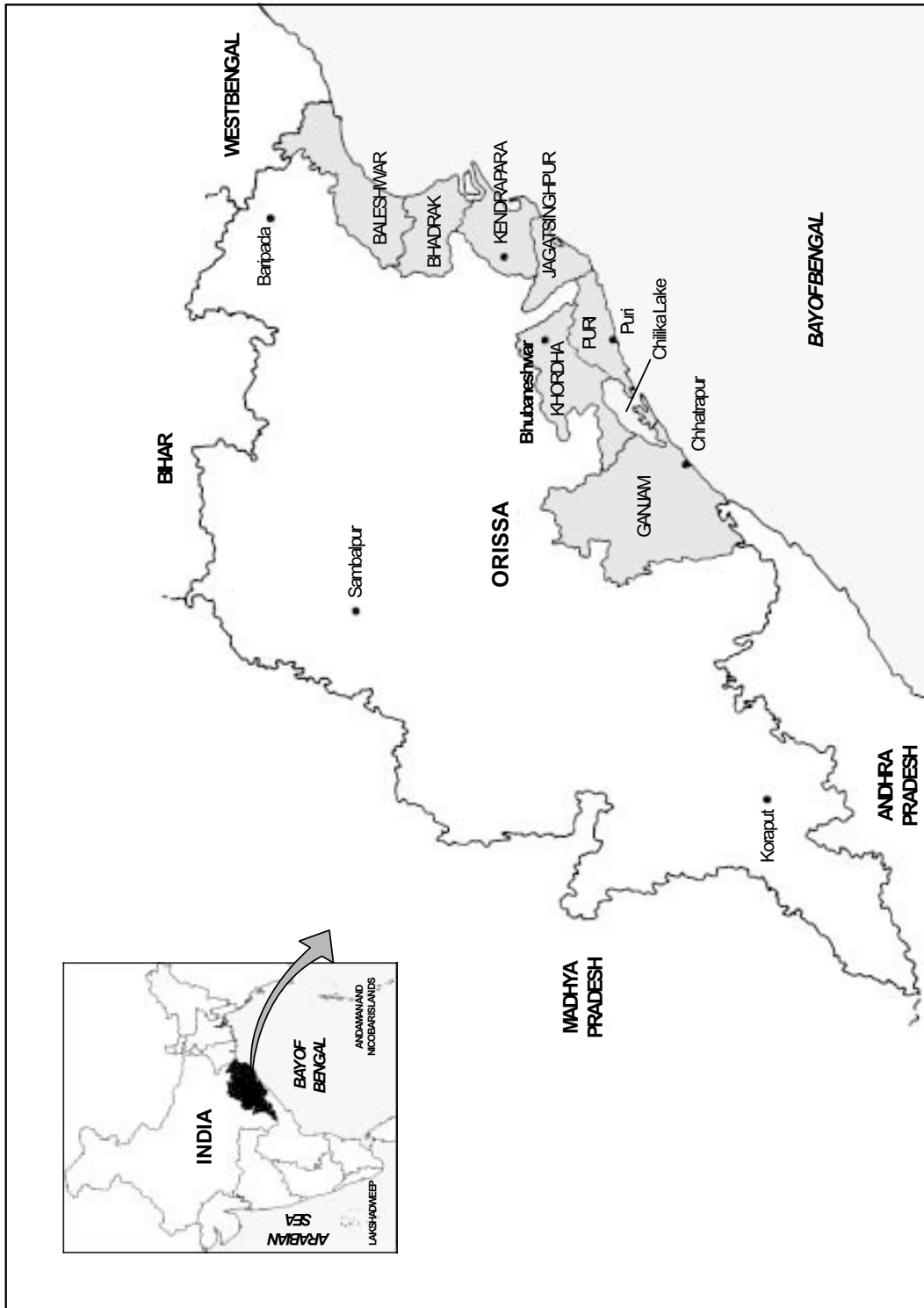
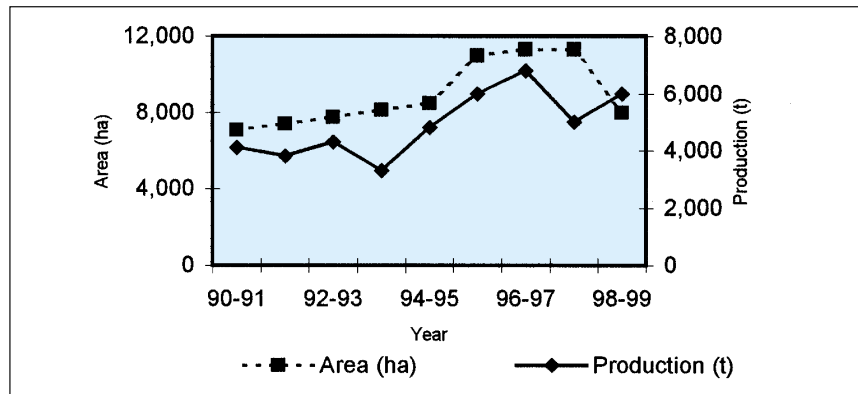


Figure 24. Coastal Districts of Orissa

Figure 25. Orissa : Area under Shrimp Farming and Total Production



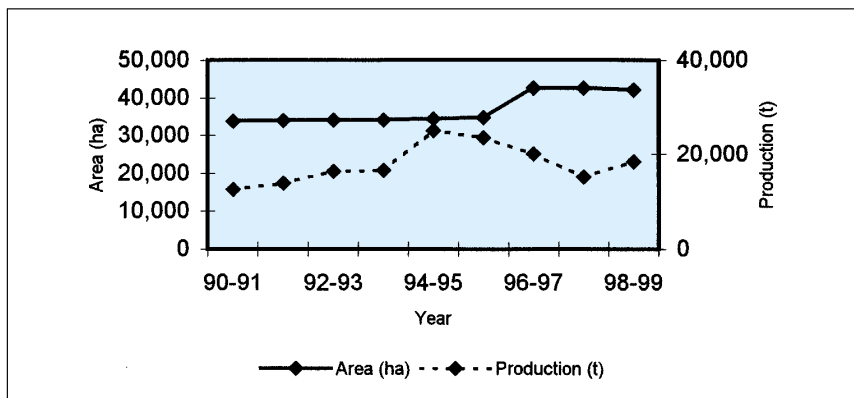
3.5.13 West Bengal

West Bengal stretches from the Himalayas in the north to the Bay of Bengal in the south. It has boundaries with Sikkim and Bhutan on the north, Assam and Bangladesh in the east, the Bay of Bengal in the south and Orissa, Bihar and Nepal on the west (Figure 26). The state has a coastline of 158 km and continental shelf of 17 000 sq. km. The total fish production during 1998-1999 was estimated at 995 000 metric tonnes, of which 171 500 (17.0 %) metric tonnes came from the marine sector.

West Bengal has the largest potential area (405 000 ha) for brackishwater farming. But so far about 48 444 ha have only been developed for brackishwater farming²⁶. Excepting for 4 678 ha under improved traditional, the remaining area falls in the category of traditional type with *trap and culture*, locally known as *bheries*. According to the recent estimates provided by the government of West Bengal, 18 479 ha of the total area was in farm holdings of less than 2.0 ha; 4 237 ha under 2.0 – 5.0 ha and the remaining 25 728 ha in farms of above 5.0 ha. All the shrimp farms are creek-based and are within the CRZ zone.

With the advent of scientific farming in the early seventies, the traditional farmers have also resorted to selective stocking with improvement in production levels. Presently, the average production from the state is about 436 kg/ha²⁷ (Figure 27). Though shrimp farming was in vogue in the state much before it started in other states, the development has been slow as compared to other states.

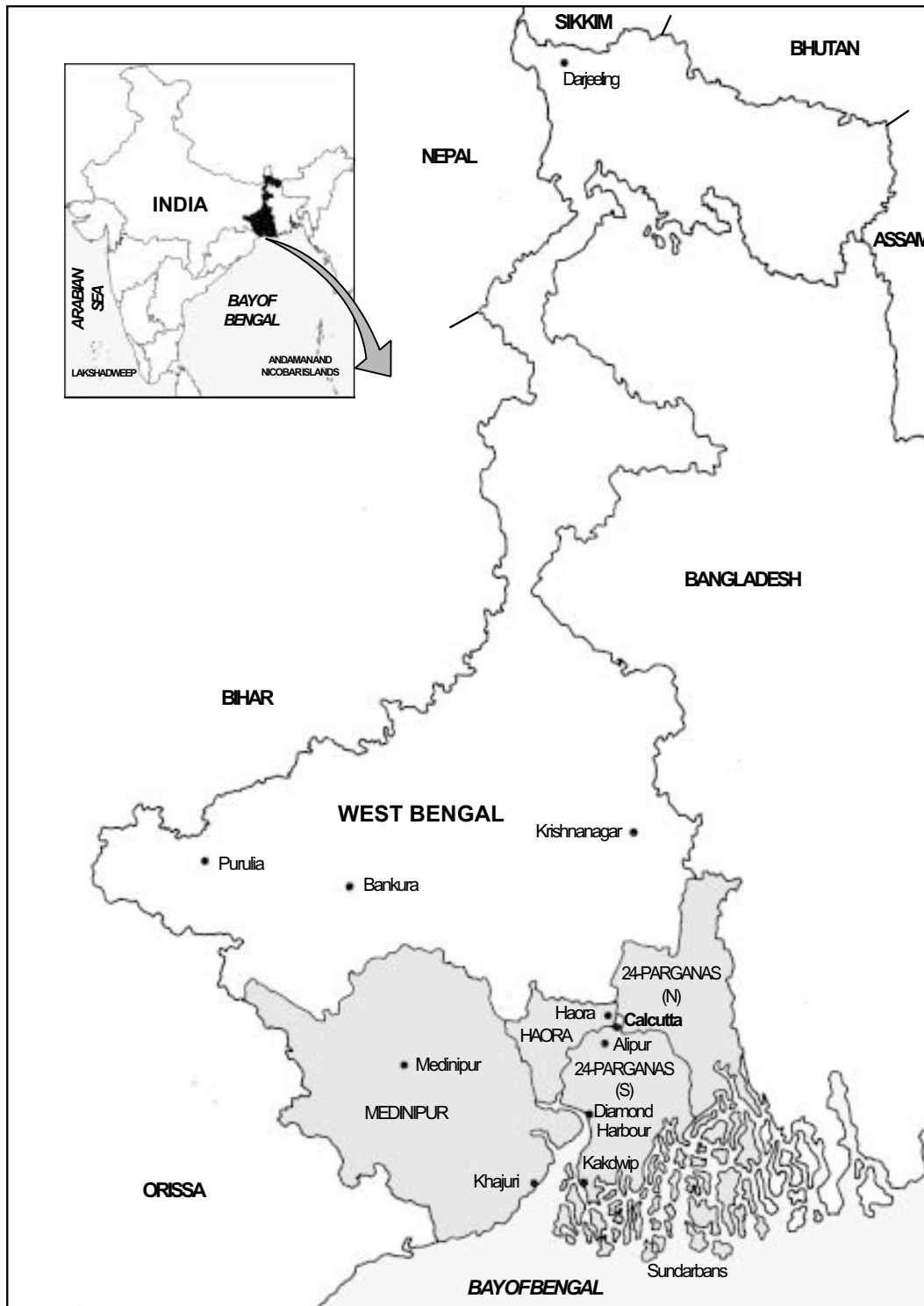
Figure 27. West Bengal : Area under Shrimp Farming and Total Production



²⁶ Government of West Bengal, April 2001

²⁷ MPEDA, 2000

Figure 26. Coastal Districts of West Bengal



3.6 Distribution of Shrimp Farms According to Holding Size

The number of farms under land holding categories of less than 2.0 ha, between 2.0 and 5.0 ha, between 5.0 and 10 ha and more than 10 ha in the different maritime states, is presented in Table 5. The data shows that more than 91.0 % of the aquafarmers own less than 2.0 ha water area. The distributing of shrimp farm area based on farm size is presented in Table 6. It is seen from this data that farms below 5.0 ha occupy 65% of the total area of shrimp farms in the country.

Table 5. Distribution of Shrimp Farms Based on the Area Holdings by Individual Farmers/ Entrepreneurs in the Coastal States of India

State	< 2.0 ha		2.0-5.0 ha		5.0-10 ha		> 10 ha		Total No. of Farmers
	No. of		No. of		No. of		No. of		
	Farmers.,	%**	Farmers	%**	Farmers	%**	Farmers	%**	
Gujarat	22	15.60	103	73.05	10	7.09	6	4.26	141
Maharashtra	74	54.00	36	26.00	13	10.00	13	10.00	136
Karnataka	393	61.69	94	14.76	48	7.54	102	16.01	637
Goa	41	24.55	19	11.36	97*	58.08	10	5.99	167
Kerala	1 297	50.00	699	27.00	234	9.00	362	14.00	2 592
Tamil Nadu	352	42.00	349	41.00	107	13.00	36	4.00	844
Andhra Pradesh	69 738	96.19	2 190	3.02	336	0.46	238	0.33	72 502
Orissa	7 580	97.88	100	1.29	51	0.66	13	0.17	7 744
West Bengal*	4 327	55.00	1 778*	29.00	1 077*	13.00	646*	8.00	7 828
Total	83 824	90.57	5 368	5.80	1 973	2.13	1 426	1.54	92 591

Source: MPEDA, 1998-99; **Percentage of total farmers in the state

Note: 90% of the farmers own farms of less than 2 ha size. In the states of West Bengal, Karnataka, Kerala and Goa, the traditional farms contribute to the higher percentage of larger water bodies.

Table 6. Distribution of Shrimp Farm Area Based on Farm Size

States	Area (ha) < 2.0 ha	2.0-5.0 ha	> 5.0 ha	Total
Gujarat	0.00	735.00	0.00	735.00
Maharashtra	32.54	139.67	540.19	712.40
Karnataka	176.87	152.52	158.43	487.82
Goa	35.91	35.53	38.94	110.38
Kerala*	765.61	382.75	956.63	2 104.99
Tamil Nadu	721.50	1 425.00	2 308.50	4 455.00
Pondicherry	16.99	47.48	90.50	154.97
Andhra Pradesh	59 174.71	5 810.62	13 716.60	78 701.94
Orissa	3 814.47	940.76	7 871.91	12 627.14
West Bengal**	18 479.00	4 237.00	25 728.00	48 444.00
Total	83 217.60	13 906.33	51 409.70	148 533.64
Percentage of the total	56.03	9.36	34.61	100.00

* Not inclusive of traditional farms of 11 319.15 ha

** Large farms are mainly traditional farms

Source: Governments of States and Union Territories

Only 10 corporate sector companies from the 500 leading corporate companies in India²⁸ are involved in aquaculture. These 10 corporate companies have taken up 1 898 ha of land, of which only 758 ha has been developed into shrimp farms. This constitutes just 0.54 % of the total water spread area of 140 936 ha developed for shrimp culture in the country. Compared to 92 591 farmers involved in shrimp farming, the companies constitute barely 0.03 % of the total farms.

3.7 Shrimp Production and Exports

India produced a total of 5.3 million tonnes of fishes during 1998-1999 of which exports accounted for 0.30 million tonnes (*i.e.*, 5.7 % of the total production) leaving behind 94.3 % for domestic consumption to meet the protein demand of the local population (Table 7). The gross value of fisheries output was Rs.222 230 million accounting for 1.38 % of the total GDP²⁹. The export value of fishery products stood at US\$ 1 107 million during 1998-1999. The bulk of the fishery exports is contributed by the marine products and it formed about 3.32 % of the total exports from India.

Out of the total export of 0.30 million tonnes of marine products in 1998–1999, shrimps contributed 0.102 million tonnes (34.0 %). However, in value terms, shrimps contributed Rs.33 449 millions (72.0 %) out of the total of Rs. 46 270 millions. Among the total shrimps exported, cultured shrimps contributed about 52.0 % on weight basis and 75.0 % on value basis. During 1999-2000, the contribution of cultured shrimps amounted to about 49.0% by weight and 76.0% by value. The details of total shrimp exports and the contribution by cultured shrimp during the last ten years are summarized in Table 8 and Figures 28 and 29.

Table 7. Fish Production and Exports

Year	Production (million t)			Export		
	Marine	Inland	Total	Quantity (million t)	%	Value (Rs. In millions)
1950-51	0.53	0.22	0.75	0.02	2.7	20
1960-61	0.88	0.28	1.16	0.02	1.7	40
1970-71	1.09	0.67	1.76	0.04	2.3	350
1980-81	1.55	0.89	2.44	0.08	3.3	2 350
1990-91	2.30	1.54	3.84	0.14	3.6	8 930
1996-97	2.97	2.38	5.35	0.30	5.6	41 210
1997-98	2.95	2.44	5.39	0.38	7.1	46 970
1998-99	2.70	2.56	5.26	0.30	5.7*	46 270

(Source: GOI, 2000)

Note: * Balance 94.3% is utilized for domestic consumption

²⁸ Business Today, 4-21, Sep. 1999

²⁹ Central Statistical Organisation : Quick estimates 1998-1999

Figure 28. Contribution of Cultured Shrimp to Total Shrimp Exports (by product weight)

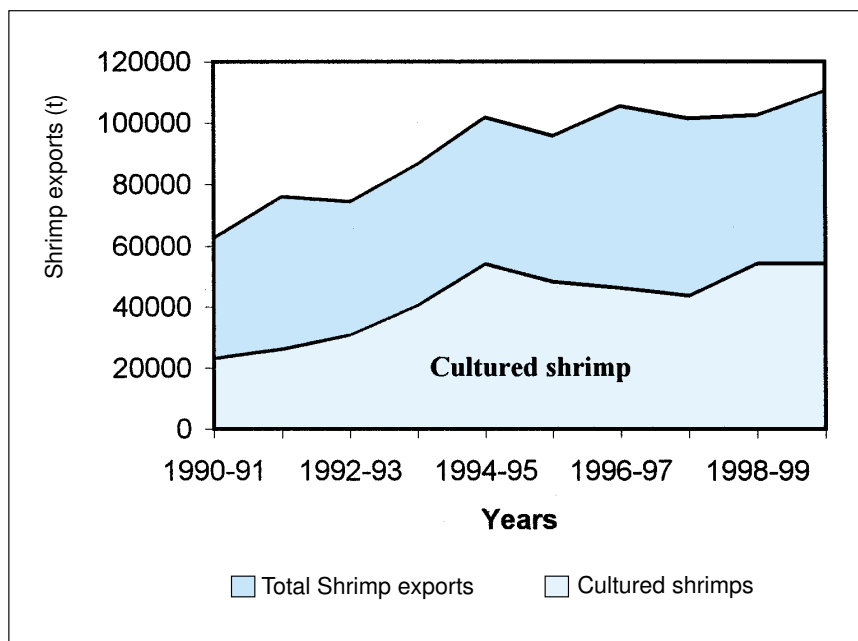


Figure 29. Contribution of Cultured Shrimp to Total Shrimp Exports (by product value)

