SOME ASPECTS OF AQUACULTURE IN THE KINGDOM OF BAHRAIN

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Abstract

Aquaculture - the managed production of aquatic organisms - has been making steady progress in recent years. Coastal and inland waters have long been used for the production of aquatic life. The need for enhancing food production to cope with the ever increasing human population has assumed vital importance all over the world. Fish and fish products are considered as the safest food of animal origin with rich protein and beneficial lipid sources for human health. Hence, attempts are made throughout the world to increase fish production. This has led to over exploitation of some groups in the capture fisheries and environmental and ecological hazards in the culture fisheries. Waste outputs from both extensive and intensive aquaculture operations and effects on ecosystem structure and function are summarized.

1.0 What is Aquaculture ?

Aquaculture means the farming of aquatic organisms, including fish, crustaceans, molluscs and aquatic plants in various systems in inland water bodies or coastal areas.

1.1 Introduction

According to FAO statistics (**FAO 2005**), aquaculture's contribution to global supplies of fish, crustaceans and molluscs continued to grow, and increased from 3.9 percent of total production by weight in 1970 to 29.93 percent in 2002. Aquaculture is growing more rapidly than all other animal food producing sectors. Worldwide, the sector has increased at an average compounded rate of 9.2 percent per year since 1970, compared with only 1.4 percent for capture fisheries and 2.8 percent for terrestrial farmed meat production systems (**FAO, 2005**).

While the rate of increase of marine fish / shrimp capture fisheries has dropped to less than one percent per year in recent years, finfish aquaculture, yields which now account for approximately nine percent of total fish production, are increasing at a rate of more than seven percent per year. The technology for producing high

value species such as shellfish - shrimps, finfish - grouper, sea bream and sea bass is progressing very rapidly. Entrepreneurs are investing heavily in new production facilities while policy makers tabulate projected foreign exchange earnings from export of the higher priced products of aquaculture. The worldwide total value of aquaculture production was assessed to be about 45.7 million tons by weight and US $ 56.5 billion by value in 2005 but expected to increase rapidly each year to attain a value of more than US $ 100 billion in 2010. In FAO 2002 statistics, more than half of global aquaculture production originated from marine or brackish coastal waters (**FAO, 2005**).

Coastal areas such as estuaries, lagoons, coral reefs, islands and bays are the major focus for aquaculture and these areas are coming under increasing pressure from the aquaculture industry. Several factors - increasing demand, improving technology and under-utilized resources - lead to the conclusion that rapid expansion of aquaculture activities can be anticipated over the next two or three decades. Sustainable aquaculture development may be attainable with coastal aquaculture practices that are environmentally non - degrading, technically appropriate, economically viable and socially acceptable.

1.12 Outcome of Aquaculture Development :

Aquaculture has been developed to serve a variety of purposes. The goals of aquaculture development are the following:

- Producing high nutritional value food for human consumption
- Contributing to rural income and employment through farming and related activities
- Enhancing capture and sport fisheries
- Cultivating ornamental species for aesthetic purposes
- Controlling aquatic weeds or pests hazardous to human or crops

1.13 Types of Aquaculture Systems:

A number of different aquaculture systems have evolved for the cultivation of the large variety of aquatic organisms in marine, brackish and freshwater environments, systems may be land or water based :

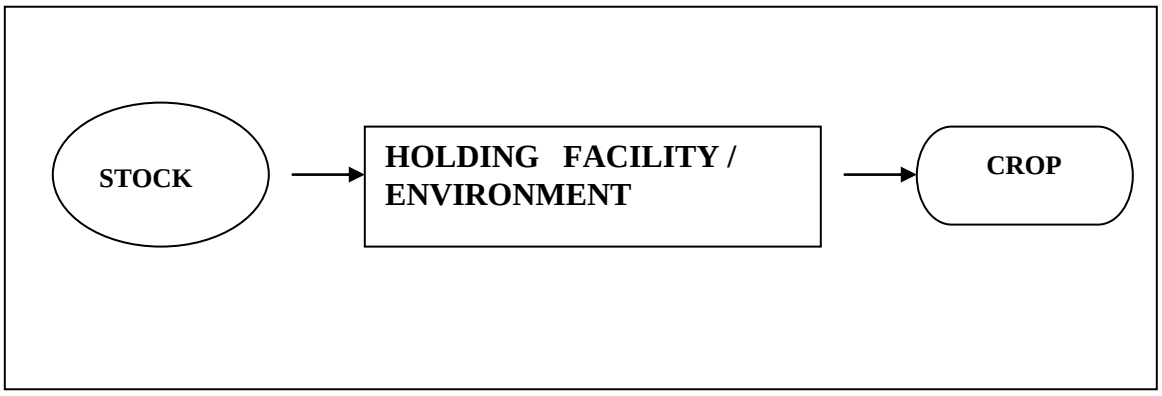
Land-based systems comprise mainly ponds, rice fields, and other facilities such as tanks and raceways built on dry land. Ponds are the most common of all aquaculture systems, and range from small, rudimentary, gravity-fed facilities to large geometric ones, constructed using machines and with sophisticated water management regimes. Carps and tilapias, both widely cultivated fish species, are commonly grown in freshwater ponds/tanks, whereas shrimp and finfish tolerant to more saline waters are cultivated in brackish water ponds / tanks.

Water-based systems include enclosures, pens, cages and rafts and are usually situated in sheltered coastal or inland waters. Enclosures are formed by closing off a natural bay, where the shoreline forms all but one side, and access to open water is closed off by a solid, net or mesh barrier. Pens and cages are enclosed structures, made from poles, mesh and netting. Pens rest on the bottom of a water body, whereas cages are suspended from poles or rafts which float on the water surface.

An aquaculture system may be characterized by its degree of intensity of farming as Extensive System, Semi-intensive System and Intensive System (Table 1).

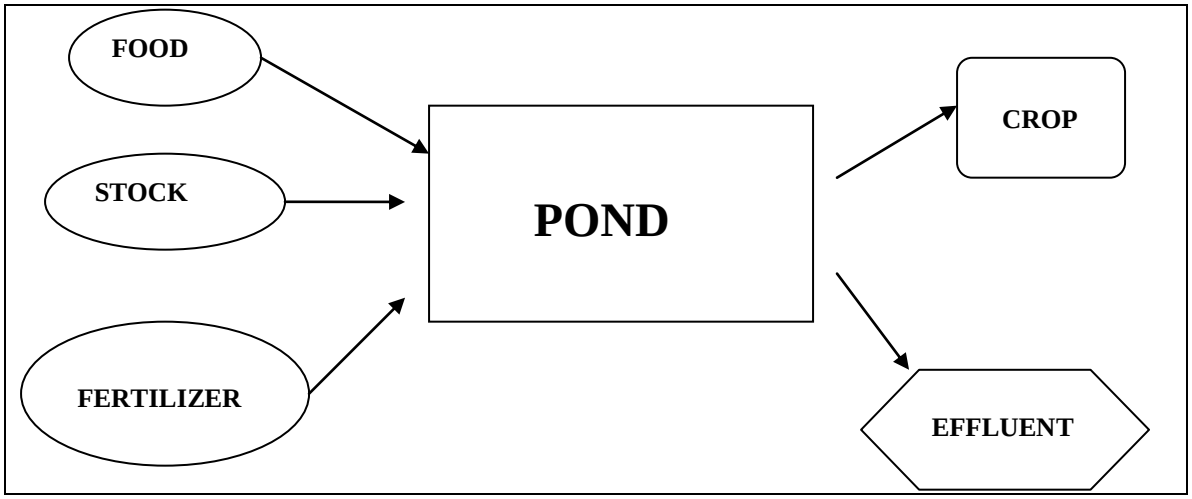
Extensive System : Extensive aquaculture usually involves unsophisticated technology, relies on natural food such as plankton for fish in the culture system and has a low input to output ratio, without intentional human intervention, although run-off and changes in water level in riverine and coastal areas may bring in both nutrients and/or food organisms (Table 1).

Extensive System



Semi-intensive System : In semi-intensive systems, fish are purposely stocked and the natural food within the system is increased by organic (manures) or inorganic fertilizers and may be complemented by usually low-cost supplementary feeds such as peanut cake, rice bran, and other agricultural by-products (Table 1).

SEMI-INTENSIVE FARMING SYSTEM



Intensive System : Intensive systems produce more output from a given production unit. This is achieved through higher levels of technology and a greater degree of management. Fish or other aquatic organisms are often reared from egg to adult stage within the culture facilities. With increasing stocking densities, chemical compounds are more commonly used to prevent disease. This system depends on the regular supply of relatively high-cost and nutritionally complete diets. Water quality is carefully controlled with the aid of filters, purifiers, sterilizers, pumps and aerators (Table 1).

INTENSIVE FARMING SYSTEM

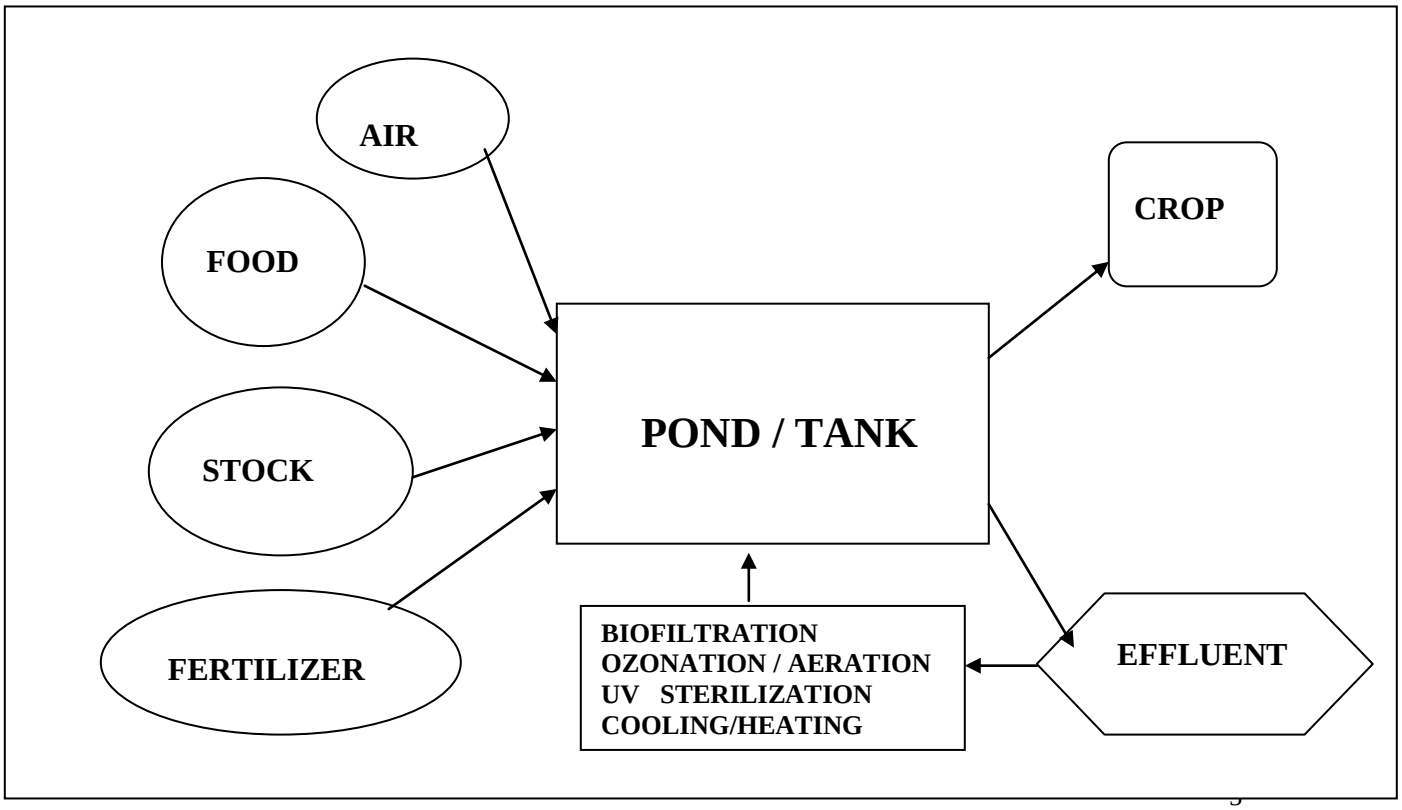


Table 1. General Characteristics of A Typical Shrimp Culture Operation

Particulars	Extensive	Semi-intensive	Intensive
Pond Size (ha)	**5+**	**1 - 8**	**0.5**
Stocking / ha	**20,000**	**80,000**	**300,000**
Fry Source	**Wild**	**Wild/hatchery**	**Hatchery**
Feed Source	**Natural**	**Natural/Supplement**	**Artificial**
Crops / year	**1 - 2**	**2 - 3**	**2+**
Survival	**50 %**	**70 - 80 %**	**70 – 80%**
Production (Kg/ha/yr)	**200 - 400**	**1000**	**4000 - 8000**
Water Management	**Tidal Exchange**	**Tidal / Aerators**	**Pumps /Filters**
Effluent Volume	**Large**	**Smaller**	**Least**
Effluent Quality	**Acceptable**	**Poor**	**Variable**

1.14 Why Aquaculture?

- Supplies from traditional ocean fisheries are decreasing due to Over-fishing and pollution.
- Demand for quality seafood is increasing due to population increase and health considerations.
- Consumers everywhere want consistency in quality and availability at the right price – Seafood is the fastest growing food industry.
- The only solution is Aquaculture – The husbandry of aquatic organisms.

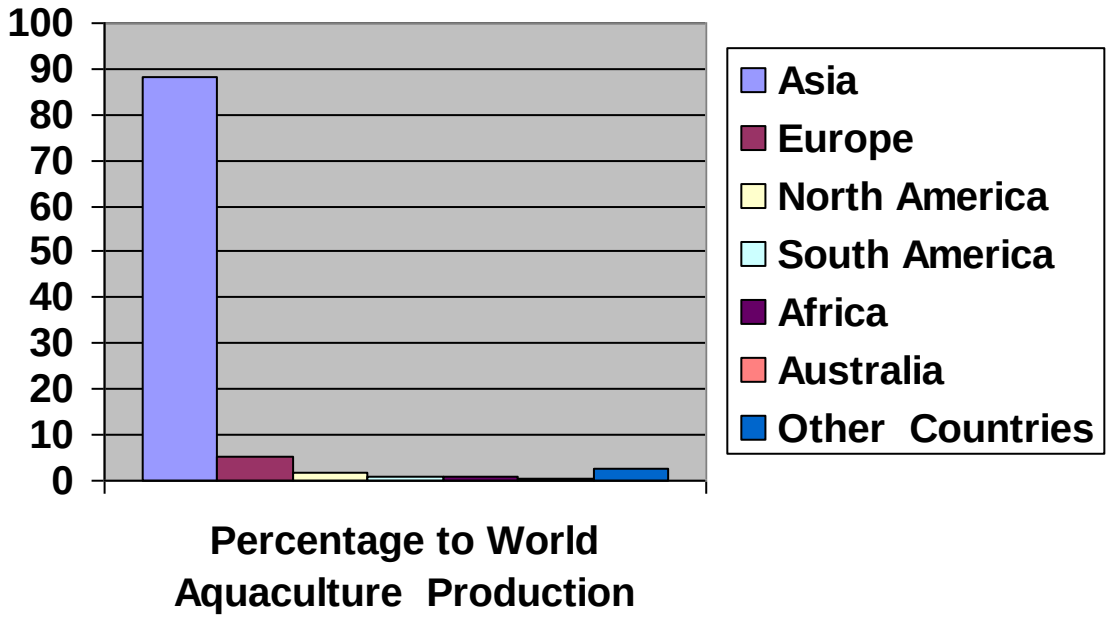
1.15 World Aquaculture Output :

World Aquaculture contributed a record of 39.80 million tons per year, valued at over US $ 50 billion. This represents nearly 30 % of world fisheries production. Aquaculture contributed 29 % of world finfish production. Finfish comprise 51 % of total aquaculture output, and 58 % of its value (**FAO,2002 Statistics, published in March,2005).**

Table. 2 World Aquaculture Production : Quantity and Percentage By Region (FAO, 2005)

Region	Aquaculture Production (million tons)	Percentage to World Aquaculture Production
Asia	35.11	88.22
Europe	2.06	5.18
North America	0.67	1.70
South America	0.40	1.01
Africa	0.38	0.96
Australia	0.09	0.23
Other Countries	1.09	2.70

Fig. 1 Regional Percentage Contribution to the World Aquaculture Production

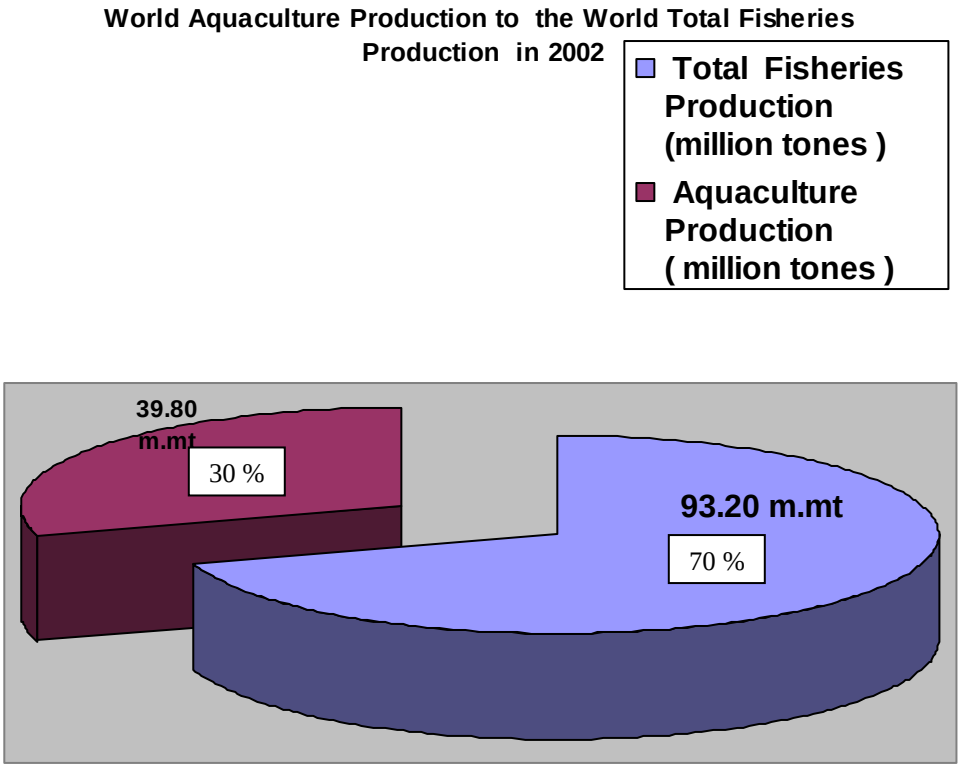


Out of the above-mentioned world aquaculture production details, 67 % of aquaculture output is from inland, freshwater aquaculture and 33 % of aquaculture output is from marine aquaculture farming. Asia is the largest producer which produced about 35.11 million tons of aquaculture products which equals to about 88.22 % of the world aquaculture production in 2002 (Table 2. and Fig. 1). Europe is the second largest producer which shared 5.18 % of the global aquaculture production (**FAO, 2005**).

Table 3. Summary of World Fisheries And Aquaculture Statistics (1996 - 2002), FAO, 2005

Year	Total Fisheries Production (million tones)	Aquaculture Production (million tones)	Percentage of Aquaculture production on Total Production
1996	93.50	26.70	22.21
1997	93.90	28.60	23.35
1998	87.30	30.50	25.90
1999	93.20	33.40	26.38
2000	94.80	35.60	27.30
2001	91.30	37.50	29.12
2002	93.20	39.80	29.93

Fig.2



The Fig. 2 depicts the percentage contribution of world aquaculture production (30 %) to the world fisheries production (70 %) in 2002. The increase in world demand is estimated at 0.5 - 3.0 % per year. On average, this means additional annual requirements of 2.01 m.tons in the EU and 670,000 tons in the USA. By the year 2005 there will be a shortage of about 20 million tons per year, and by 2010 it will increase to 40 million tons per year. The increasing demand can only be satisfied by aquaculture (Table 3 & Fig.2) (**FAO, 2005**).

Table 4 World Aquaculture Production By Resources 2002 (FAO, 2005)

Resource	Percentage Contribution to World Total Aquaculture Production
Finfish	**51.0**
Crustaceans	**4.2**
Molluscs	**17.0**
Aquatic Plants	**27.0**

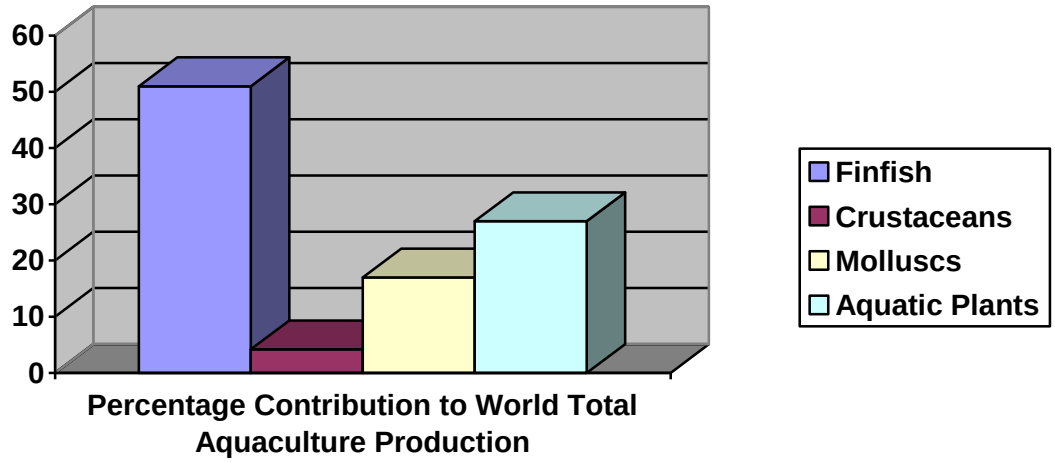


Fig. 3 World Aquaculture Production By Resources

Figure 3 shows the percentage contribution of different aquaculture products to the global total aquaculture production. Aquaculture production of finfish is 51 % which dominates among the other aquaculture products (Table 4). World trade in seafood is estimated at more than US $ 100 billion. The major markets are those of Japan, USA and EU, which depend on imports, ranging between 30 – 60 % of their consumption (**FAO, 2005**).

2.0 Aquaculture Development in the Near East

In general, aquaculture has a short history in the Near East Region when compared to other parts of the world. The overall aquaculture production in 1997 is below 200,000 tons, a figure that represents less than 0.5 percent of global aquaculture production. The rate of growth of aquaculture development within the decade 1988-1997 ranges from almost nothing to over 60 percent in some countries. Table 5 demonstrates that eight of the 17 regional countries produced nearly 99 percent of the total regional aquaculture production in 1997; Egypt – 47 percent ; Turkey – 29 percent ; Israel – 12 percent ; Syria – 3 percent ; Saudi Arabia – 3 percent ; Iraq – 2 percent ; Morocco – 2 percent and Tunisia – 1 percent.

Table 5. Aquaculture Production (MT) in the Near East in 1988 and 1997 (FAO, 2000)

Country	Aquaculture 1988	Production 1997 (MT)	% of Aquaculture world Fisheries 1988	Production to Production 1997
Algeria	304	322	0.4	0.2
Bahrain	0	0	0	0
Cyprus	59	969	0.1	0.6
Egypt	52 200	73 454	64.0	46.9
Iraq	5 000	3 400	6.1	2.2
Israel	15 135	18 264	18.5	11.6
Jordan	70	200	0.1	0.1
Kuwait	8	154	0.0	0.1
Lebanon	100	300	0.1	0.2
Libya	30	100	0.0	0.1
Morocco	158	2 290	0.2	1.5
Oman	--	--	0.0	0.0
Qatar	--	2	0.0	0.0
Saudi Arabia	331	4 690	0.4	3.0
Syria	3 040	5 596	3.7	3.6
Tunisia	1 053	2 012	1.3	1.3
Turkey	4 100	45 450	5.0	28.9
UAE	6	--	0.0	0.0
Yemen	0	0	0.0	0.0
Grand Total	81 594	157 203		

2.1 Role of National Mariculture Centre (NMC), Directorate of Marine Resources (DMR) on the Development of Aquaculture in the Kingdom of Bahrain

Large-scale commercial aquaculture has not been started in Bahrain but, in 1979, the National Mariculture Centre was started as a pilot project, in cooperation with the Food and Agriculture Organization of the United Nations (FAO). The centre is located at Ras Hayan (Fig.4) in southeastern Bahrain, and has the following objectives

- To create the scientific and technical base for the development of mariculture operations in Bahrain
- To conduct appropriate scientific research projects and developmental programs on mariculture of living marine resources
- To develop suitable culture systems for the conducive environmental conditions of the Kingdom.
- To assist and encourage private sector investments in commercial/industrial fish farming and similar activities in the country.
- To mass produce seeds of suitable and commercially important species for the fish farming sector.
- To grow fingerlings to market size fish in the suitable culture systems for the local and international markets.
- To train national staff in aquaculture technology.
- To assist stock enhancement programs through the mass production of seeds / fry / fingerlings to protect the local endangered marine resources from extinction.

The research activities of the centre include studies on the nutrition and reproduction of rabbitfish, ***Siganus canaliculatus***. Growth trials have been done for different species which includes for eg. rabbitfish and grouper in different culture systems and the green tiger shrimp, ***Penaeus semisulcatus***, is also being studied. The mariculture developmental programs of the NMC are the expansion of the center by adding new infrastructure, conduct applied research studies to identify the suitable culturable species (Table 6) and systems and finally to promote commercial level aquaculture based on the NMCs' results.

Fig.4 Location of National Mariculture Centre (NMC) at Ras Hayan

Table. 6: Commercial Candidate Species for Culture in Bahrain

English Name (Local name in parenthesis)	Scientific Name
Brown-spotted Grouper (Hamoor)	*Epinephelus coioides*
European Seabream	*Sparus aurata*
Green Tiger Shrimp (Rubian)	*Penaeus semisulcatus*
Mangrove Snapper (Sheggar)	*Lutjanus argentimaculatus*
Rabbitfish (Safee)	*Siganus canaliculatus*
Sobaity Bream (Sobaity)	*Sparidentex hasta*
Streaked rabbitfish (Saffy senaify)	*Siganus javus*

In 1994, stock enhancement trials were started using hatchery-reared grouper and seabream, where releases were made at eleven sites in Bahrain. Currently, production is carried out for the first three species. The sobaity bream being the major contributor. Given the state of freshwater resources in Bahrain, all efforts now are being diverted to the marine species. The aquaculture production of National Mariculture Centre, Bahrain is summarized in Table 7.

Table 7. Aquaculture Production of Kingdom of Bahrain at NMC For Years 1993 – 2005

Year	Species	Fry Production (> 1.0 g)	Number Of Fish Released In Open Sea For Stock Enhancement Programme	Fish Harvest (MT)
1993	Grouper	6,500	----	----
1994	Rabbitfish	4,000	----	0.5
	Grouper	19,000	10,000	1.0
	Seabream	17,000	7,000	---
	Total	40,000	17,000	1.5
1995	Rabbitfish	59,000	300	3.0
	Grouper	11,000	10,000	0.7
	Shaem	7,000	3,000	0.3
	Total	77,400	13,000	4.0
1996	Rabbitfish	59,000	----	2.4
	Grouper	12,000	----	----
	Shaem	120,000	124,250	----
	Total	191,000	124,250	2.4
1997	Sobaity Bream	650,000	150,000	----
1998	Sobaity Bream	142,000	-----	1.1
1999	Sobaity Bream	659,000	7,500	2.5
2000	Sobaity Bream	525,000	-----	11.5
2001	Sobaity Bream	395,000	100,000	----
2002	Sobaity Bream	540,000	NA	NA
2003	Sobaity bream	240,000	160,000	
	Rabbitfish	30,000	-	
	Mangrove snapper	4,000	-	
2004	Sobaity bream	370,000	-	6 . 313
	Rabbitfish	97,800	-	0. 682
	Mangrove Snapper	-	-	0. 770
2005	Sobaity bream		-	
	Rabbitfish		-	1. 148
	European Seabream		-	

2.2 Present Aquaculture Scenario of the Kingdom of Bahrain

At this time, there is no commercial mariculture industry in Bahrain. All research and production efforts are focused on development and refinement of appropriate environmental friendly and economically efficient and commercially viable technology. The major activities of the NMC is now aimed at producing fish juveniles for sale and for release programs, a modest contribution of mariculture towards natural resource rehabilitation, and production of juveniles for a limited grow-out operation in concrete ponds. The only effect on the marine environment from the NMC is the effluent water which currently does not exceed 100 m3 / hour. This effluent water is first allowed to the reservoir for the settlement of suspended matter before discharging it in to the sea. In the absence of commercial aquaculture activities in the Kingdom of Bahrain, there is currently no clash between aquaculture and fisheries.

2.2 Why does Kingdom of Bahrain need Aquaculture?

The kingdom of Bahrain has a tremendous potential for fish farming practices considering the advantages offered by climate, location, coastal area, and market. Virtually, many types of aquaculture practices are feasible here, and all sorts of aquatic organisms can be cultured successfully. The kingdom of Bahrain, by virtue of its location in the Arabian Gulf, possess rich finfish and shellfish resources. Some of these have already been identified as suitable for aquaculture production by the National Mariculture Centre, Bahrain. Modern practices of culture intensification makes it possible to produce marketable fish sizes in the climatic conditions of the kingdom. There is great potential for the development of aquaculture in the kingdom.

There is a huge deficit in fish supply in the kingdom. While the demand is increasing, the catch from the sea bordering the kingdom has stagnated at about 90 % of its sustainable yield (**GDPMR Fishery Statistics Report, 2003**). As a matter of fact, the global campaign now is for aquaculture as a replacement for the dwindling marine resources. Fish as a health-food will continue to enjoy high demand and good market price in the face of glut and downward review prices in other trade commodities. The international community is far a larger market to absorb any quantity the country could not consume. None of the agriculture products has the high exchange value of fish. Furthermore, the global fishery product consumption per capita has increased drastically during the last two decades due to health awareness and realization of the benefits of fish consumption instead of red meat by the public (**FAO, 2002, published in March, 2005).**

In the long run, investment in the exploitation of this renewable resource will contribute to Bahrain's food security and self-sufficiency and earn foreign exchange to the National Economy through the export of aquatic products.

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