Status and Development Trends of Aquaculture in the Near East[1]

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ABSTRACT: Aquaculture has a short history in the Near East Region. The overall aquaculture production in 1997 was below 200 000 mt, a figure that represents less than 0.5 percent of global aquaculture production. 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).

The scarcity of, and competition for water and land from other users, as well as rising input costs are encouraging culture intensification. The use of artificial feeds, aeration and fertilizers is increasing to semi-intensive levels. A recent trend is the development of the marine sector to culture high-value species. The availability of seed of some species such as seabass, seabream and shrimp, proximity to export markets, and the establishment of joint ventures have provided the impetus for rapid development of mariculture. However, freshwater aquaculture development will likely be shaped by national water and land polices. The over-riding consideration is scarcity of fresh water and land. Reduction in groundwater levels, prohibition in the use of fresh water, and competition with agriculture, the petroleum industry and tourism are major constraints that need to be resolved to facilitate expansion of the sector.

Availability of seed and feed are crucial technological constraints to future development. The high price of feed, exacerbated by currency fluctuation and high variable costs, has raised production costs. The uptake of aquaculture is also frustrated by poor legislation, especially for environmental protection and movement of aquatic animals, as well as the bureaucratic requirements for obtaining licenses and permits. Cooperation between institutions and agencies is weak. In some cases, their functions overlap or are conflicting. A widespread concern in the region is the weakness of extension services and the slow dissemination of technology.

Most of the aquaculture produce, especially tilapia, carps and grey mullet, is consumed locally. Cultured marine species are produced for export, but the competitive and high prices obtained locally and new and more costly European Union (EU) regulations have combined to discourage exports.

KEY WORDS: Near East, Aquaculture, Fish Farming, Development, Aquatic Production

Review of aquaculture production in the near east

Aquaculture development

The growth of aquaculture in Turkey has been the most impressive, moving from around 5 percent of the region's production to just over 30 percent.

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 mt, 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 1 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).

The data presented in this table also demonstrate the development trends, regardless of the absolute production volumes, which reflect the short history of aquaculture within the region. Nonetheless, the data indicate that significant developments are taking place within the aquaculture sector, notably for Cyprus, Egypt, Morocco, Saudi Arabia, Syria, Tunisia and Turkey.

Table 1 indicates the importance of both the volume and the regional contribution for each country within the region. Furthermore, within national production, there are very significant differences in the breakdown of the products, For example, the production of aquaculture in Lebanon is devoted to one species, rainbow trout (Oncorhynchus mykiss), which is also the major aquaculture product in Turkey, while gilthead seabream (Sparus aurata) represents the backbone of aquaculture development in Morocco and Cyprus. Nile tilapia (Oreochromis niloticus) and the giant tiger shrimp (Penaeus monodon) have been significant contributors to aquaculture development in Israel and Saudi Arabia.

There have been considerable changes in the structure of aquaculture in the Near East, which becomes evident through analysis of the water source used and the culture environment (fresh water, brackish and marine), as demonstrated in Figures 1 and 2.

Table 1. Aquaculture production (MT) in the Near East Region in 1988 and 1997 (FAO, 2000).

Country	Year		APR*	Regional Production	
	1988	1997		1988	1997
Algeria	304	322	0.6%	0.4%	0.2%
Bahrain	0	0	-	0.0%	0.0%
Cyprus	59	969	36.5%	0.1%	0.6%
Egypt	52 200	73 454	3.9%	64.0%	46.7%
Iraq	5 000	3 400	-4.2%	6.1%	2.2%
Israel	15 135	18 264	2.1%	18.5%	11.6%
Jordan	70	200	12.4%	0.1%	0.1%
Kuwait	8	154	38.9%	0.0%	0.1%
Lebanon	100	300	13.0%	0.1%	0.2%
Libyan Arab Jamahiriya	30	100	14.3%	0.0%	0.1%
Morocco	158	2 290	34.6%	0.2%	1.5%
Oman	-	-	-	0.0%	0.0%
Qatar	-	2	-	0.0%	0.0%
Saudi Arabia	331	4 690	34.3%	0.4%	3.0%
Syrian Arab Republic	3 040	5 596	7.0%	3.7%	3.6%
Tunisia	1 053	2 012	7.5%	1.3%	1.3%
Turkey	4 100	45 450	30.6%	5.0%	28.9%
United Arab Emirates	6	-	-	0.0%	0.0%
Yemen	0	0	-	0.0%	0.0%
Grand Total	**81 594**	**157 203**	**7.6%**		

* APR = Average Percent Rate

Figure 1. Analysis of aquaculture production (by quantity) in the Near East by culture environment (water use) from 1988-1997 (FAO, 2000).

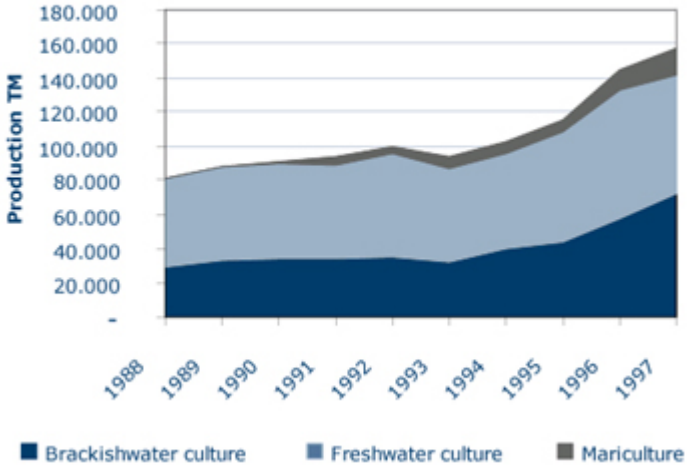
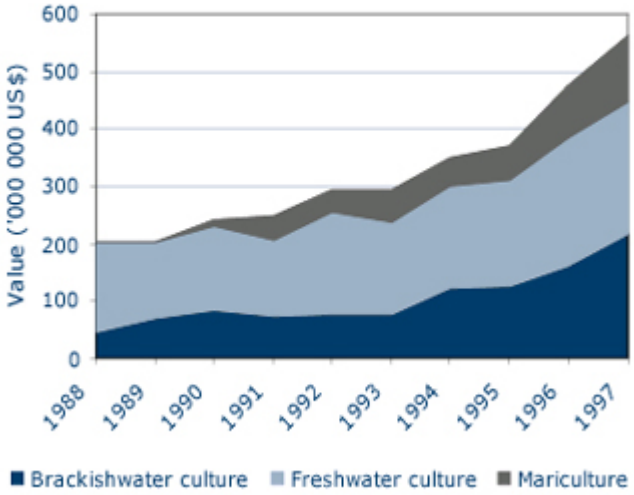


Figure 2 Analysis of aquaculture production (by value) in the Near East by culture environment (water use) from 1988-1997 (FAO, 2000).



The increasing importance of the value contributed by marine aquaculture, which has provided products of higher individual value, is noteworthy. The major contributors to the different subsectors are given in Table 2.

The data demonstrates the increasing importance of the use of brackish and marine water for production, rising from 36 percent (entirely brackish) in 1988 to 56 percent in 1997 (10 percent marine and 46 percent brackish). The APRs (Average Percent Rate) for the period were 3.2 percent for freshwater, 10.5 percent for marine and 64.6 percent for brackishwater aquaculture.

Stagnation is seen for carp production in fresh water, where a degree of substitution has been accorded (at a regional level) by tilapias. On the other hand, carp production has increased in brackish water, accompanied by tilapias, but mullets and seabream have achieved the largest growth. In the marine sector, which hardly existed in 1988, the expansion is evident, primarily for the seabream and seabass species, although one should note the growth seen for mussels and marine trout production (mainly in Turkey).

Main culture systems

Aquaculture production in the Near East Region is characterized by wide diversity, not only in regard to the culture systems used, but also in respect of the development trends and issues of concern. This position makes it valuable to summarize the status of aquaculture in member countries, highlighting important issues within the development process.

Table 2. Ranking of aquaculture species in different culture environments in the Near East (1988-1997).

		Production (quantity)			Value		
Culture System	**Species**	**1988**	**1997**	**APR**	**1988**	**1997**	**APR**
Brackish water	Nile tilapia	20 000	28 500	4.0%	30 000	58 653	7.7%
	Common carp	6 000	15 396	11.0%	6 000	22 632	15.9%
	Flathead grey mullet	2 200	16 034	24.7%	6 160	47 142	25.4%
	Gilthead seabream	294	9 802	47.6%	1 867	71 847	50.0%
Fresh water	Trouts nei[1]	1 765	32 340	38.1%	9 708	92 780	28.5%
	Common carp	37 267	25 921	-4.0%	116 194	84 914	-3.4%
	Nile tilapia	5 300	13 762	11.2%	8 622	14 023	5.6%
	Tilapias nei	5 256	8 209	5.1%	13 944	19 047	3.5%
Mariculture	Seabasses nei	5	8 660	129.0%	60	56 700	114.1%
	Gilthead seabream	62	3 031	54.1%	930	29 031	46.6%
	Trouts nei	0	2 290	-	0	7 000	-
	Mediterranean mussel	0	2 000	-	0	6 000	-
	Giant tiger prawn	2	1 681	111.3%	19	6 649	92.1%
	European seabass	3	1 218	94.9%	45	4 910	68.4%

[1] nei = not elsewhere included.

Culture technology

The technology used for fish culture varies widely within the Near East, but most production comes from earthen ponds. However, different levels of intensification are applied using extensive, semi-intensive, and intensive systems. Integrated systems that combine fish production with other types of agriculture also exist in the region, where rice-fish culture is an example of note.

The general characteristics of such systems in the region are described in the following section. It should be noted that the interpretation used in this review of what is "extensive" or "semi-intensive" has changed both with time and location.

Extensive aquaculture systems

Extensive culture is done in dam lakes in a number of Near East countries, including Iraq, Israel, Syria, Morocco, Algeria, Tunisia and Libya3, where common carp, grass carp, silver carp and sometimes tilapia are stocked. Mullets are stocked in Lake Qarun and the Rayaan Depressions in Egypt. In addition, the enrichment of natural stocks is also considered to be a sub-type of this system, where grouper, seabream and rabbitfish have been placed in waters of some countries in the region. The extensive aquaculture system applied in earthen ponds represents that of the lowest inputs throughout the production cycle and also the minimum control. Sometimes, this system is helpful in utilizing agricultural by-products that cannot be used in higher category systems.

As expected, the risk factors are at their lowest in such systems but, because of the increasing value of natural resources (especially water and land), the low productivity obtained explains the trend of "upgrading" to higher culture categories that allow more efficient use of water, land and labour.

Semi-intensive aquaculture systems

As the term indicates, "semi-intensive" reflects a higher degree of intensification and greater control over the culture habitat. More feeds are used, and of better quality (especially manufactured feeds) and more fingerlings are used within a given volume of rearing system. A key result is the improved use of natural resources due to higher productivity levels. Higher investment and skills are needed to

Intensive aquaculture systems

A high degree of control over the production operation is a must for the intensive system, leaving few options to Mother Nature. Nutritionally complete feeds are essential for growth, while continuous water exchange and/or supplementary aeration are usually required. Smaller ponds (than in semi-intensive farming) or tanks/raceways are used for better management. Because of the high investment and production costs, farms using "intensive" technology are developed after careful economic study and are usually applied to the raising of high-value fish, such as seabass or seabream, examples of which can be found in some countries in the region.

Cage culture represents a type of intensive system that does not require large areas of land and, in most cases, necessitates lower capital investments when compared to land-based intensive farms. Cage culture is developing moderately well in the region and could be considered to have significant promise for increasing aquaculture production in many countries. Environmental considerations are the main challenge for further development.

The integration of aquaculture with rice production is the most common type of integrated agriculture that is practised in the region (especially in Egypt), although trials with other crops have been done on a small scale.

National reviews of aquaculture in the region

Algeria

Freshwater aquaculture started in Algeria, in 1967, with the conditioning of water bodies at Mazafran. This initial effort was followed in 1978 with a programme, supported by Algerian-Chinese cooperation, for the reproduction and culture of carps. From 1985 to 1991, 17 water bodies were stocked with fry of Chinese carps, pikeperch (Stizostedion lucioperca) and sheat (Silurus sp.), leading to a significant increase in fish production. For example, Lake Oubeira developed production of 250-300 mt of freshwater fishes, dominated by Chinese carps. Unfortunately, no data are available post-1991. In 1989, two freshwater pilot hatcheries were

establish and operate such a system, which appears to lead the other aquaculture systems applied within the region.

built for the production of fingerlings of pikeperch, grass carp and silver carp.

Trials on molluscs started in 1976 in Singa Island, Bou-Ismail Bay and Lake Mellah, but with little success. Little extensive production of mussels (Mytilus galloprovingialis) is done in coastal waters.

Bahrain

Commercial aquaculture is not done 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 on Ras Hayan in southeastern Bahrain, and has the following objectives:

- to produce seed of commercially important species,
- to grow fingerlings to market size,
- to train national staff on aquaculture technology,
- to assist and promote similar activities in the country, and
- to assist stock enhancement programmes through the mass production of seed/fry/ fingerlings.

The activities of the centre include studies on the nutrition and reproduction of rabbitfish (Siganus canalicatus). Growth trials have been done on rabbitfish and grouper in different culture systems and the green tiger shrimp, Penaeus semisulcatus, is also being studied. In 1994, stock enhancement trials were started using hatchery-reared grouper and seabream, where releases were made at five sites in Bahrain.

Cyprus

Aquaculture in Cyprus has a short history, production being less than 200 mt in 1992, but this reached nearly 1 000 mt by 1997. Total aquaculture production is dominated by the rearing of gilthead seabream and European seabass (Dicentrarchus labrax), and the country possesses true offshore cage-culture facilities for this purpose. The main product in 1997 was seabream, which comprised 80 percent of the total.

A major factor hindering development is the application of import taxes by the export markets targeted. Nonetheless, it is believed that offshore developments will provide the main focus for future growth.

Egypt

Egypt has been the traditional leader in aquaculture production in the Near East Region. Egyptian aquaculture started with the use of traditional extensive and semi-intensive techniques. Rapid development has occurred in recent years, after aquaculture had been identified as the best answer to reduce the increasing gap between supply and demand for fish in Egypt.

Progress was very slow until the late 1970s, then rapid change occurred in all forms of aquaculture activity, including the development of support infrastructure (i.e. hatcheries and feed mills). This resulted in a noticeable increase in the production of cultured fish, which reached more than 73 000 mt, representing some 19 percent of the total fish production of Egypt in 1997. Production in fresh and brackish water is the main source; only 453 mt were harvested from marine aquaculture.

The majority of fish farms in Egypt can be classified as semi-intensive brackishwater farms. This type of farm is increasingly vulnerable because of the competition for land and water between this activity and the requirements of land reclamation for agriculture, and the numbers are anticipated to drop significantly.

Intensive culture in earthen ponds and tanks is now developing quickly as a response to the potential drop in number of the semi-intensive farming units. The success of this trend depends largely on the new private-sector groups (e.g. private enterprises or cooperatives) that have joined the fish-farming activity. These groups have adopted higher levels of production technology and use more responsible approaches to resource use. Private farms now represent 89 percent of the area occupied by fish farming, and most of these are individual entities, although there are six cooperatives.

Cyprus also produces commercial quantities of fry for these species and has developed significant export markets, notably to producers in the European Union (EU), for these products. A small amount of rainbow trout is produced within the island (90 mt per annum).

A national development strategy aims to increase the annual per capita consumption of fish from the present level of 10 kg to 13 kg by the year 2017, and to ensure the availability of low-priced fish to the consumer, either from national production or from imports.

Types of Aquaculture

Extensive aquaculture

Extensive aquaculture is applied in inland lakes, rivers and irrigation canals in Egypt. Brackishwater lakes (e.g. in the Rayaan Depressions, 16 000 ha, 4 ppt salinity) are mainly stocked with mullet and carps (silver, bighead and grass carp), while Lake Qarun (23 000 ha of 36 ppt salinity) is mainly stocked with mullets (Mugil cephalus; Liza ramada and L. salina).

Stock enhancement programmes were made in Lake Quarun with sole (Solea vulgaris) in the 1960s and European seabass, gilthead seabream and green tiger shrimp in the late 1970s. These programmes were done to support artisanal fisheries and to reduce the decline in productivity, since most of the freshwater species that used to inhabit Lake Qarun had disappeared because of the increase in salinity.

The River Nile and the irrigation network of the Nile Valley have been stocked with grass carp for weed control since 1994, while black carp has been stocked since 1997. While these activities are done within the National Project for Biological Control, they provide considerable support for fisheries in the Nile Valley. Out of a total catch of more than 65 000 mt, about 12 000 mt represent the harvest of stocked grass carp. These projects are managed by the General Authority for Fish Resources Development (GAFRD) development programme and financed by both the Ministry of Irrigation and the Ministry of Public Health.

Canals, ponds and lakes in the different oases in the western desert are stocked with tilapia and common carp to supply the local population with fresh fish. The first harvests were recorded in 1985.

Semi-intensive aquaculture

Intensive aquaculture

While not very common in Egypt, five farms are using intensive tank culture to produce 500 mt of fish per year, mostly tilapia. About 1 000 cages have been sited in the north of the River Nile, having a total volume of about 210 000 m3. Other cage sites have been developed in Lake Manzala and Lake Temsah. Current annual production of cages is above 2 100 mt.

Although irrigation authorities have not encouraged cage culture in the River Nile, because of pollution and/or navigation issues, this activity is expected to greatly expand in the coastal lagoons during the next few years, being monitored and controlled by local environmental departments. The government views the activity not only for food supply criteria, but also as a means of solving unemployment problems.

Integrated aquaculture

The importance of rice-fish culture has fluctuated according to the areas put to rice cultivation. There has been a considerable expansion in rice-fish area in the 1980s with a peak in 1989, at a time when the price for rice was not favourable and new reclaimed salt-affected land was taken under cultivation with continuous flooding and fish production. This situation changed after 1989. Rice prices increased, the adoption of high-yielding varieties led to a higher productivity, and reclaimed lands were converted to rice monoculture (Halwart, 1999). Fish production from this system peaked at 28 000 mt in 1989 (233 000 ha), reducing to 21 000 mt in 1996 and slumping to only 7 000 mt in 1997, when only 58 000 ha of rice were integrated with fish. The position in 1997 was a direct result of the abandonment of the free delivery of fingerlings to farmers. Following this situation, the Ministry of Agriculture decided to restore the policy and, in the future, production is expected to increase.

Aquaculture locations

Semi-intensive aquaculture provides about 75 percent of Egypt's total aquaculture production (about 64 000 mt), and most farms are located in the northern or eastern parts of the Nile Delta. The water supply for these farms comes from agricultural drainage water. There is great variation in the degree of intensity, types of input, level of management and the size and type of infrastructure. This type of farming covers about 78 000 ha, while the average productivity ranges between 0.7 to 4.3 mt/ha/yr. Tilapia contributes 44 percent of the annual harvest, followed by mullets (25 percent) and carps (24 percent). Seabass and seabream contribute 3.5 percent each within the total.

Aquaculture in coastal lagoons

Egyptian coastal lagoons are preserved for free access to fishing, an activity that represents 31 percent of the total fish production. Fisheries are allowed in all areas, except near the sea openings.

Despite this rule, some fish farms exist within the coastal lagoons. The "Hosha" system is usually applied; this is an old practice that involves enclosing an area within a water body by dykes. Fish are attracted into the "ponds", or are stocked directly, and kept until harvest.

Land-based coastal aquaculture

Most of this activity is located in the northeast of the Nile Delta (Damyetta), the Suez Canal areas and the Sinai and focuses on the production of high-value fish such as gilthead seabream, European seabass and shrimp (Penaeus sp.).

Coastal fish farming depends on wild-collected fry as seed stock (except for shrimp farms). These farms use large, shallow ponds and have a limited water supply of mediocre quality, a factor that affects productivity. New farms in the Suez Canal and Sinai areas have established hatcheries for their own supply, as well as for others. Additional hatcheries are currently under construction. The government is encouraging coastal aquaculture to compensate for the expected decline in brackishwater yields. It is hoped to attract higher levels of corporate investment, which would imply a more developed technological activity and better management.

In-shore aquaculture

This activity is limited to only 10 cages, sited in a coastal lagoon in South Sinai, which have a total annual production of 30 mt of seabream. Nonetheless, the activity is expected to develop and expand once appropriate fingerlings are available.

As the numbers of hatcheries increased and the requirements of the fish-farming industry became clearer, production patterns have changed slightly. Common carp still represents 49.5 percent of the total number produced (1998), where rice culture is the major recipient. A significant increase has been seen in the production of grass carp fingerlings (+283 percent) to be stocked in water canals for weed control purposes. At present, however, insufficient numbers of tilapia fingerlings are produced in governmental hatcheries to match the need for fish farm requirements.

Private-sector hatcheries produced only 17.5 million fingerlings in 1995, representing less than 5 percent of Egypt's total production. However, these hatcheries focus on tilapia supply (16.5 million or 94.3 percent of fingerlings), a circumstance that promotes tilapia culture. This means that about 43 percent of the tilapia fingerling supply came from private hatcheries in 1995. This situation became even more pronounced by 1998, when many small and medium-size hatcheries were producing all-male tilapia fingerlings. Twenty private hatcheries produced 32 million tilapia fingerlings, while the 14 governmental hatcheries provided 18 million. These levels of production still do not meet demand. One governmental hatchery produces the postlarvae (PL) of freshwater prawn (25 000 PL/yr).

A marine governmental hatchery has been established near Alexandria to support marine aquaculture development, while several private marine hatcheries have been built recently. In 1998, about six million fingerlings were produced

Services for aquaculture (inputs)

Fish hatcheries

In order to support the needs of the growing fish farming industry, governmental freshwater fish hatcheries were established starting from the early 1980s. Currently, 14 state hatcheries produce about 90 percent of the total fingerlings produced in the country. These hatcheries are well distributed to provide their production of fingerlings to fish farms, rice fields and natural waters. Annual production was 27 million fry in 1982, reaching 306 million in 1995.

Freshwater fish hatcheries lead production statistics, where carps (especially common carp) are the major species reared.

of seabream, seabass, red tilapia and shrimp, accompanied by an estimated 4-5 million shrimp postlarvae. Recently, a new shrimp project has started, and this includes a hatchery for production of around 200 million of P. semisulcatus.

Collecting stations

Several collecting stations, sited around the coast, distribute wild-caught fingerlings. In 1998, a total of 129.5 million were collected, of which mullets are the dominant species
(99.2 percent), the remainder being seabass and seabream. The harvesting and distribution of wild-caught fingerlings is done and supervised by the GAFRD. While subject to seasonal fluctuation, the yields have ranged from 95.9 million (1993/1994) to 148.4 million (1989/1990).

Fish feed and fertilizers

Manure (especially chicken manure) and chemical fertilizers are used in extensive and semi-intensive aquaculture.

For semi-intensive and intensive aquaculture, supplementary feeds are used. Originally, these were pelleted cattle feed, cottonseed oil cake, wheat and rice bran, and the production and use of specifically formulated fish pellets is relatively new. Most of fish feeds produced locally have been for supplements to other feed inputs, and the quantities produced meet present needs.

Cost factors have influenced manufacturing processes, and the five feed mills (governmental and private) tend to produce fish feed of sinking (hard) pellets of 17-25 percent protein content. Pelleted feed use has expanded recently and, about 20 000 mt of formulated feeds are made annually. Some feed mills have extruders for the production of floating pellets. With the exception of fishmeal and some meat meals, all other ingredients are available from local suppliers.

However, it is of the author’s view that although the existing capacity of Egyptian feed manufacture is capable, to a certain extent, of supporting the growing industry, some types of feed has yet to match the international quality of feeds (shrimp feeds and specialized feeds for hatchery requirements are examples). Such feeds continue to be imported from Europe, the

The supply of tilapia fry at the appropriate time is seen as a major constraint for future development. Because of the high marketability of some marine fish and shrimp species, more attention has been given to their aquaculture potential, notably for European seabass, gilthead seabream, and green tiger shrimp. Their impact will be dependent on the success of national hatchery supplies.

The effects of the accidental entry of some species cannot be ignored. African catfish (Clarias lazera) and Nile perch (Lates niloticus) are examples of this. Because of their predatory behaviour, these species may have an impact on populations in fish ponds, especially if they are present in number and/or large sizes. Nonetheless, there is a preliminary interest in the cultivation of both species.

Introduced species

In 1934, the common carp (Cyprinus carpio) was introduced from Indonesia while the mirror carp strain was brought in from France in 1949. With the construction of hatcheries in the 1970s, more carp species were introduced. The grass carp (Ctenopharyngodon idellus) was taken from Holland in 1977 for weed control. Subsequent propagation of the species was successfully achieved. Silver carp (Hypophthalmichthys molitrix) and bighead carp (Aristichthys nobilis) had been brought in previously from Thailand (1954) and Japan (1962). However, their

United States and Japan. Nonetheless, there is increasing adoption of formulated feeds by traditional farmers because of good productivity results.

Major aquaculture species

Indigenous species

Mullets, especially the grey mullet (Mugil cephalus), have been one the major species since aquaculture started; the market is good and fry can reach market-size within one growing season. Because of the shortage of grey mullet fry to supply aquaculture needs, M. capito stocks were used as a supplement. However, an additional nursing season is required to grow this specie to market size.

Tilapias are now the main cultured species, notably Oreochromis niloticus, O. aureus and Sarotherodon galilaeus. While Tilapia zillii is seen as undesirable, this species can "contaminate" ponds in large numbers by wild infestation or through the water supply system.

contribution to aquaculture was not significant until the hatcheries were able to produce adequate quantities. Carp species now contribute significantly to Egyptian aquaculture, especially in government fish farms. Common carp is stocked in rice fields and grass carp fingerlings are stocked annually in canals and drains. The last carp species to be introduced (in 1993) was the snail (black) carp (Mylopharyngodon piceus), which is so-called because of its capacity to control snails in fish-culture habitats. Studies are being conducted to investigate their feeding habits and possible effects on the ecosystem.

Red tilapia hybrids have since been introduced, targeting better use of saline waters. The freshwater prawn (Macrobrachium rosenbergii) has been also introduced from Malaysia and Thailand in the 1980s for use in mono- or polyculture systems. The introduction of crawfish (Procambarus clarkii) is a fact, but the reasons for its presence are not clear.

Iraq

The first fish farm in Iraq was established in 1965 with an area of 2 ha. By 1995, 1 727 farms were operational, having a total area of 3 200 ha, and which produced 3 400 mt of carps (valued at US$34 million) in 1997. The potential production for such an area, if appropriate inputs (notably feeds) were available, is at least 18 000 mt of fish. Productivity per unit area is low in most fish farms, ranging from 1 400 to 2 000 kg/ha. This low productivity is attributed mainly to the shortage of adequate fish feeds.

Most fish farms in Iraq are extensive, and small farms (1-10 donems (donem = approximately 2 500 square metres)) represent more than 80 percent of the total number. The productivity of these farms is very low due to modest management systems and low input levels. Cage farming expanded in the early 1980s in Habania Lake, but was eventually abandoned for commercial production, limiting its use to research.

Israel

Israel has shown slower growth than several other nations in the region and has been

Key issues encountered have been to increase production efficiency, in order to reduce market prices, and species diversification, a goal that is reflected in the growth of certain species. Mullets and gilthead seabream became increasingly important contributors after the mid-1990s, while hybrid striped bass and red drum also made their appearance in production statistics at this time.

In the mid-1990s, a considerable effort was put over to investing in new infrastructure in aquaculture, particularly tilapia farming and effective over-wintering facilities (due to heavy losses in cold weather in 1991-1992). The anticipated increases of these investments started to be registered from 1995. Improving productivity to render aquaculture products more competitive in the market place and reduce imports is another core consideration of this policy. There has been a degree of interchange in production, where reductions have been seen for some "traditional" species (e.g. common and silver carp), while others have increased (e.g. seabream, tilapias, mullets). This reflects a move towards marine aquaculture as opposed to the traditional freshwater activities, noting that the species cited also have higher individual values than the freshwater species cultivated.

displaced by Turkey as the second most important producer, following developments through the decade. Nonetheless, more than 18 000 mt were produced in 1997, represented by eight major species. Production has traditionally been dominated by the use of multipurpose reservoirs, which were responsible for 46 percent of the surface area used for aquaculture in 1995, and polyculture systems predominate. The competition for water, combined with market factors, resulted in an important shift away from the use of dedicated fish ponds (Sarig, 1996).

Important climatic differences between the northern and southern regions, combined with increased water consumption in all areas, has meant that inland aquaculture has been given low priority, having to target brackish water and sources not suitable for agriculture or domestic use. As a general target, optimized water use (recycled city water, desalinated brackish water, recycling systems) will remain a key factor in future development. Strategies for improved water use are under examination, focusing on dual-purpose applications (e.g. within reservoirs) and/or use of recycling systems (Mires, 2000).

Jordan

Fish culture in Jordan started in 1965, following investigations to use effluent water from mirror carp to irrigate agricultural crops. The main goal was to demonstrate aquaculture viability in Jordan, accompanied by supplying carp fingerlings to farmers and stocking dammed lakes. Annual production between 1966 and 1978 was 20 000 to 30 000 fingerlings, which encouraged the establishment of carp farms. The project was terminated in 1978 for administrative reasons. There are 24 fish farms, with a total area of 13 ha, which produced 200 mt in 1997. Carp and tilapia are the main species produced. Most of the farms are very small, consisting of a few ponds that contain different species of varying sizes, and use farm by-products for feeding. Three projects exist of a more intensive nature, but none is fully operational yet. One hatchery exists in the North Shuneh region of Jordan.

Kuwait

Kuwait possesses clean, non-polluted sea water with an average temperature that gives an excellent environment for fish culture.

However, the coastline is open and unprotected from severe weather; normal conditions include strong winds, waves and currents. Kuwait has promoted marine aquaculture, adopting floating cages as the technology of choice. The natural conditions impose investment for artificial and technical protection, increasing both the construction and operating expense. Feasibility studies have indicated that a production level of 400-600 mt/yr could both support such additional costs and be profitable.

There are 65 fish farms in Kuwait that use integrated aquaculture technology, occupying a total area of about 36 000 m2, and most are operated as extensive units. The government favours farms that use higher levels of management (i.e. using nursery facilities, growout and fattening ponds), supplying free imported feeds while more modest facilities only receive 25 percent of feed requirements; this policy is to promote more efficient and professional production.

There has been a growing interest in marine fish species, such as sobaity (Sparidentex hasta) and

Recirculated brackish groundwater tanks or ponds made from durable materials, using constant aeration/oxygenation, can be used for tilapia culture, providing fish of 500-700 gm at densities of 12-15 kg/m3. Tilapia hatcheries using established technology are profitable enterprises.

Lebanon

Freshwater fish farms were first established in Lebanon in the early 1960s, both in cold and warm water, and trout, carps and tilapia have been cultivated. There are about 40 small fish farms, mostly concentrated in the Beqaa area, culturing rainbow trout. Although the annual capacity of these farms is about 500 mt, production is only 120 mt, which is attributed to low market demand, especially for freshwater fish species, as well as difficulties in obtaining the required inputs (feeds). The Lebanese Aquaculture Center, which was established in the 1960s, encouraged the development of fish farms, supported by the Ministry of Agriculture.

Libya

grouper (Epinephelus coioides), as well as tilapia spp., which can be cultured in brackish or sea water. Acanthopagrus latus has recently been spawned for the first time.

Only one marine farm exists in Kuwait, which uses intensive cage culture for local and European seabream, grouper (E. coioides) and she'em (yellow-finned black porgy, Acanthopagrus latus). Production started in 1992, aiming at around 200 mt annually.

Surface freshwater and groundwater resources are limited, and the costs of use restrict the possibilities of aquaculture development. Some 50 integrated farms exist, using higher salinity groundwater for water supply, but annual production is low (0.5-1.5 mt per well).

Techno-economic assessments of the species and appropriate aquaculture systems combined have been made to identify the positive options for development, such as integration of tilapia production with agriculture. This could take the form of integrating tilapia with vegetable crops, which are irrigated only in summer, and should yield around 1 mt fish/well (500 litres/min). A second option is to integrate tilapia with alfalfa, requiring year-round irrigation, yielding around 2 500 kg fish/well (500 litres/min). If 25 percent of the 847 operating wells were used, 530 mt of tilapia could be produced annually, imposing a need for a hatchery producing 1.5-2 million fry/yr.

Aquaculture started in 1977, exploiting dammed reservoirs made to catch rainfall. Common carp, silver carp, grass carp and catfish were stocked in these facilities. Similarly, carps were stocked in the Lake of Wadi Magnene (126 ha), while carps and tilapias have been stocked in other dams. Annual production statistics indicate that 230 mt of freshwater fish (mainly carps) are produced from 146 ha of freshwater lakes, and that production appears stagnant due to a lack of consumer demand for carps. Some 100 integrated farms have been established in the southern region, employing concrete tanks supplied with ground water, for tilapia production and using the wastewater for agriculture production.

The first marine fish farm was established in 1989 in Ain Ghazala, which has 180 ha in addition to about 500 ha of marshes. This farm acted as an enclosure to receive mullet and seabass fry collected from the lake. To support the marine aquaculture activity, a project has been established at Ain Zayyanna, targeting production of 2 million fry of seabream and seabass, as well as 400 mt of market-size fish of these species. Trials on shrimp culture have been of varying success; following tests with native and imported species, production of Penaeus japonicus postlarvae (originally imported from Egypt) had increased to about 2 million by 1997.

Experimental trials have been started on mussel culture (Mytilus edilis) in the western parts of the Libyan coastline.

Nile tilapia and red tilapia hybrids are being grown in cages in Ain Kaam Gulf, using stocks imported from Egypt.

Morocco

The first aquaculture activities in Morocco can be traced back to the 1920s, when oysters (imported from nearby European countries, such as Portugal and France) were maintained until sale during festive seasons. However, mariculture in Morocco has not advanced quickly, being limited only to coastal farming of oysters (Atlantic) and finfish (Mediterranean). Some 200 mt of oysters and 1 000 mt of seabream and seabass are cultured annually.

There are five oyster farms on the Atlantic coast whose products are sold locally. Attempts to produce oysters and clams within the lagoons and estuaries of the Mediterranean coast have encountered technical and commercial difficulties, leading to the virtual abandonment of these activities, concentrating only on finfish (seabass and seabream) in cages. A small-scale industry for clams (60 mt) and mussels (320 mt) exists in certain sites on the Atlantic coast, where carpet-shell clams and mussels are fished and stored before sale. The large-scale production of scallops (Pactinopecten yessoensis) at Khinifiss is projected, using spat imported from Canada, where annual production is foreseen at levels approaching 2 000 mt. In regard to finfish, there are two fish farms located on the Mediterranean coast.

Mariculture has been developed through private initiatives, while freshwater fish culture was started by government authorities. In 1925, the Ministry of Agriculture established a station to repopulate naturally occurring brown trout in the waters of the Middle and High Atlas Mountains, leading to the present situation where private and government interests operate farms for the intensive culture of rainbow trout and carps. Trout (100 mt) are for local consumption, while carps (1 000 mt) are used primarily for weed control. Generally, the per capita fish consumption in Morocco is not very high (about 7 kg/yr).

Mariculture is controlled by the Ministry of Fisheries, while freshwater aquaculture is the responsibility of the Ministry of Agriculture. Mariculture initiatives have included pilot-scale mussel farming, and studies on rearing blue-fin tuna (Thunnus thunnus) have started in cooperation with Japan. Freshwater centres have investigated the hatchery production of a wide range of species, including brown and rainbow trout, pike, perch, pike-perch and black bass. The introduction of fingerlings into freshwater bodies for fishing has been promoted. Similarly, the production of carps for weed control is under governmental supervision.

Two large fish farms exist on the Mediterranean coast (at Nador and Moulouya), devoted mainly to the cage culture of European seabass and gilthead seabream, whose products are exported to markets in neighbouring European countries.

Three enterprises are engaged in freshwater fish farming but, due to the poor local market for these species, there is little private investment interest. Two companies that are specialized in carp production have answered the need for weed clearance in reservoirs built for irrigation and potable water supply. Only one company is involved with trout farming (100 mt/yr), which has also tested the production of sturgeon and other species, although a second project is projected to achieve the same production level.

Oman

Aquaculture is a new activity for Oman. In the 1980s, there were trials to culture giant tiger shrimp (Penaeus monodon), but it is believed that the Indian shrimp (P. indicus) is more promising. A large fish-farming project exists, involving the Ministry of Agriculture, national and international companies.

Qatar

Experimental mariculture started in 1988, and technical studies have been done on a variety of marine fish species within an experimental farm, but commercial aquaculture has yet to achieve significance.

Saudi Arabia

The first aquaculture project started in 1982 and, by 1996, over 95 projects were operating. In 1996, production of more than 3 500 mt of tilapia and catfish was attained. Shrimp farming started with modest yields in the 1980s, exceeding 100 mt in 1991 and over 1 000 mt in 1998.

These range from simple technology to those of intensive aquaculture. Consequently, installations range from ponds to concrete or fibreglass tanks that are land-based, using wells for groundwater supply. Feeds are made locally, formulated according to dietary requirements, and are subsidized for fish farming. Aeration or oxygenation is a common practice, but few farms are mechanized with, for example, automatic feeding systems. Food conversion ratios are normally 2-2.5 for tilapia species, and annual productivity rates for the tilapia farms range from 5 to 25 kg/m3.

By 1997, public investment in aquaculture maintained 15 enterprises (260 ha farms, 70 000 m3 cages). The authority has actively encouraged private-sector investment, and there are nearly 500 private fish farms with an area of 700 ha. The overall contribution of aquaculture reached about 5 000 mt in 1997.

Syria has lakes and dams, with an area of about 100 000 ha, that have been stocked with some 25 species of Cyprinidae, Mugilidae, Siluridae, Mastacembelidae, Bagridae, Gobitidae and Cichlidae. Eleven governmental farms produce around 1 000 mt of fish and about 7 million fingerlings. The authority also owns four cage

Saudi Arabia is rich in marine resources, possessing a 1 600 km coastline along the Red Sea and 500 km along the Arabian Gulf. Both coasts have sheltered bays, mangrove swamps, mud flats and onshore plains that provide suitable sites for either land-based farms or for cage and pen culture. Both water quality and climatic conditions are favourable for mariculture activities. The Red Sea coast has more stable salinity (42-44 ppt) and better sea temperatures (21-31 °C) that are more suitable for marine shrimp culture than those of the Arabian Gulf (42-55 ppt and 12-35 °C).

Currently, there are three shrimp farms on the Red Sea that raise both tiger shrimp and Indian shrimp, each farm being able to supply its own needs of postlarvae. Although it was felt that the Indian shrimp holds higher promise, the tiger shrimp has given the highest yields (nearly 1 700 mt in 1988), using strains collected from the Red Sea that have a higher salinity tolerance.

The major species produced in freshwater systems are the Nile tilapia, the blue tilapia (Oreochromis aureus) and red tilapia hybrids, while common carp and African catfish (Clarias gariepinus) are also reared. All fish farms rely on groundwater drawn from surface or deep wells, and effluents are used for the irrigation of plant crops within integrated systems. Because of water supply limitations, intensive culture is the system of choice, since higher productivity (20-40 kg/m2) can be obtained, but closed and semi-closed systems (ponds, tanks and cages) are also widely used. In the southwestern region of the kingdom, three dams (Gizan, Negran, Abha) contain 1.85 billion cubic metres of fresh water, within which the Ministry of Agriculture and Water is planning to develop freshwater aquaculture.

Syria

The earliest aquaculture trials started in 1957, and the General Authority for Fisheries, established in 1974, has the responsibility for supervising and promoting aquaculture projects.

Crustacean aquaculture has been investigated, but no satisfactory results have been obtained as yet.

In 1989, a national project was launched to evaluate the appropriate fish culture technology

farms producing 690 mt of fish. The private-sector farms produce 3 500 mt of food fish and 15 million fingerlings.

All types of aquaculture systems exist, but most installations are based on semi-intensive practices, where annual productivity rates are between 4-10 mt/ha. These rates have been achieved through the use of better quality feeds, higher stocking densities and the maintenance of good water quality. Intensive culture is represented mainly by cage culture, where annual productivity is between 30-60 kg/m3. Carp and tilapia are the main species, while rainbow trout may be stocked once colder climatic conditions set in (December to April), following the harvest of the installations. Two farms use raceways for farming rainbow trout, producing 160 mt and one million advanced fingerlings for the "replacement" stocking described previously.

Tunisia

While oyster culture has 40 years of history in Tunisia, further developments occurred following the establishment of national centres, during 1975 to 1984. The first commercial marine fish farm was built in the 1980s, and there are now five farms having a total production target of 1 300 mt of marine fish species. Hatcheries supply 7 million fry of seabass, seabream and mullet, and annual yields of marine fish have increased from 510 mt (1988) to 800 mt (1997).

Among the problems facing marine aquaculture, the effects of toxic algae (dinoflagellates) have been notable, causing significant cage mortalities in 1991-1994. Plans exist for the promotion of mollusc culture through the construction of farms and hatcheries, where annual production of about 8 000 mt is targeted. The total production of molluscs (mainly Mytilus galloprovincialis), from aquaculture was around 400 mt in 1988, declining to 65 mt in 1997.

As with other regional exporters, Turkish exporters have had to adhere to the regulations concerning food safety and hygiene, conditions that have caused some problems to the sector. An export ban on national fishery products (including aquaculture) disrupted the market in

to be used in dams, where mullet, carp and other freshwater fish species are reared. Within the country, some 14 000 ha of dammed water bodies exist. Currently, about 5 million fry are transferred annually to 12 large dams (10 000 ha total area). By 1997, fish production from these projects amounted to 700 mt, where mullet represents about 40 percent of the yield. The use of conditioned hot water springs is also being investigated, potentially for adapting to tilapia culture.

Turkey

Aquaculture in Turkey has shown almost exponential growth since 1988, increasing its annual production from 4 100 mt to over 45 000 mt. Where carp was the major product in 1988, this was rapidly overtaken by competitive products, and its production has reduced by two thirds (from 2 200 mt to 800 mt).

The main species produced now is rainbow trout, representing 63 percent of all aquaculture in 1997, while the other major species are seabass species and gilthead seabream. Some 85 percent of the trout produced is portion-size, which is mainly consumed in the local market, while the other 15 percent are large trout (over 1 kg individual size) that are produced in cages in the Black Sea. The harvest of large trout has to be achieved before high summer temperatures, an operating condition that may limit expansion of this subsector, while the portion trout market remains interesting. Very little of this product is exported, being taken up by the domestic market.

The mariculture sector continues to expand its production, which was influenced initially by an attractive European Community (EC) export market. While seabass led production in the mid-nineties, this place was taken up by seabream in the later years of the decade, partly as a result of epizootic problems. The culture of marine shrimp (Penaeus sp.) started in 1995. Finfish mariculture provided less than 200 mt in 1988, growing in size and scale to provide over 13 500 mt by 1997. A major part of this production targeted the EC market, notably in Italy.

In Morocco, preferential loans can be obtained

the late 1990s, creating severe economic difficulties within the sector. Nonetheless, this stimulated marketing actions by the production sector in Turkey, with very positive results.

Investments have been made in the sectors of fishmeal and feed manufacture, allowing the supply of improved feeds to both the freshwater and marine aquaculture sectors, a factor that has contributed to the rapid expansion seen in the 1990s.

United Arab Emirates

The United Arab Emirates (UAE) has an extensive coastline of about 700 km, facing the Arabian Gulf on the western coast and Gulf of Oman on the east. Numerous islands and lagoons provide an ideal environment for marine resources. Historically, the country has strong links with maritime activities, and the government gives due importance to both agriculture and fisheries. In 1984, the Marine Resources Research Center (MRRC) was established, and experimental aquaculture is a key element of its programme. While performing a wide range of studies on husbandry and feeding research on fish and crustaceans (particularly shrimp), this has yet to be translated into significant aquaculture production.

Yemen

Aquaculture in Yemen is confined primarily to experimental work on marine fish and crustacean (shrimp) aquaculture, which is being done at the Aquatic Research Centre in Aden.

Financial assistance for aquaculture development

Aquaculture, has a short history in the region and has taken time to develop to its current level. The application of technology and improved management and husbandry systems requires investment, both in operating costs and in materials. A short review of the credit systems available within specific countries of the region demonstrates some of the difficulties faced by farmers wishing to develop their aquaculture activities.

Constraints for aquaculture

for short-, medium- and long-term periods from a governmental bank, covering 70 percent of total project costs and requiring guarantee. An EU-Government development scheme in the northern mountain area can provide up to 90 percent, without guarantee, for as long as the project investment does not exceed US$ 280 000. No projects have yet benefited from this scheme.

Loans are, however, difficult to obtain, due to administrative delays. To date, only three projects have benefited from loans allocated to aquaculture. To facilitate obtaining loans for aquaculture development, certain suggestions have been made:

- the purpose and advantages of the credit should be made well known to the farmers;
- such credits could be associated with extension services, so that aquaculture techniques and advantages can be popularized;
- the lending banks should get further financial assistance from national or international donor agencies; and
- specialized training in credit management for aquaculture projects may be required for local banks.

In Saudi Arabia, interest-free loans are provided to farmers for the development of aquaculture projects, including the purchase of machinery and facilities. Such loans are normally extended over 10 years, with a grace period of one or two years. Moreover, the government subsidizes fish feed and farm equipment.

There is more than one credit line available for aquaculture development in Egypt, where one of the most important is the NG Aquatic Resources Activists Support Fund. This is a nongovernmental union that provides support to all members who work in fisheries and aquaculture. Interest-free loans can be provided to small-scale aquaculture and fisheries projects. In addition, the Government Young Graduates Support Fund can finance selected small-scale projects. A new credit line programme in cooperation with the EC, provides soft loans to aquaculture projects of varying importance.

Actually obtaining the loan is not so easy, since banks require collateral that is often beyond the ability of the small farmer, a position that is exacerbated by the perceived risks of the activity. It will take time before banks appreciate that the risk of aquaculture is no higher than that of other agricultural activities.

development in the near east

Aquaculture, as any other agricultural activity, is affected by different factors that enhance or inhibit its development. The factors are of a technical, economic, legislative or institutional nature. The severity of the different constraints encountered explains the gap seen between production and production capacity. The following section summarizes some common constraints encountered within the region, giving specific examples seen at national levels.

Technological constraints

Dependency on wild stock sources for seed

For example, the limitation of wild mullet fry is affecting the stocking level of dams in Tunisia and fish farms in Egypt.

Insufficient hatchery production of fish seed

This appears to be an important factor in many countries in the region, illustrating the need to apply the appropriate technology to produce seed stock for marine fish and shellfish requirements (e.g. Tunis, Algeria and Bahrain) or reduce imports (e.g. Kuwait). This was quite a big problem in Turkey, but investment in hatcheries has contributed to alleviating the requirements of wild seed. The limited availability of tilapia fingerlings of particular sizes at specific times is visibly hindering aquaculture development in Egypt.

Insufficient production of specialized fish feeds

Specialized industrial fish feed manufacture does not exist in most regional countries, due to the lack of raw materials and manufacturing technology, imposing imports as a necessity for aquaculture. Even where manufacturing capacity exists, specialized feeds for hatchery and ongrowing still must be imported. Prime suppliers of formulated feeds are the Netherlands, France and China. This situation increases direct production costs, which have to be countered by increased productivity.

Inadequacy of project conception and design

There is a clear need for an improved design capacity for aquaculture projects within the region, where specialized national aquaculture engineers are required; this would reduce the damaging effects of poorly designed and engineered projects on production.

Competition from other sectors

In Cyprus, Egypt, Tunisia and Turkey, competition in the coastal zone areas is evident, where other development sectors, notably tourism and industry, are challenging aquaculture for access to the coastal resource.

Insufficient training

This is a critical factor in almost all countries of the region, where there is a lack of skilled managerial and technical personnel to assist the development of marine aquaculture and advance technological requirements.

Inadequate water supplies

Increased salinities and expanding agricultural irrigation are but two of the factors that are restricting the availability of water to aquaculture, creating problems for aquaculture project management.

Scarcity of suitable sites

This is a clear restriction in much of the region, where there are few locations that are genuinely suitable for aquaculture project development.

Limited capacity of scientific research for technology development

Although there are several aquaculture research institutes in the region, the contribution of these institutes to real development is limited, either because of inappropriate research targets or because of the absence of effective aquaculture extension.

Economic constraints

The increased cost of aquaculture projects, particularly those based on intensive technology, poor credit resources for aquaculture, and high interest rates on credit are some economic constraints that the region is facing for aquaculture development. Furthermore, many banks view aquaculture as a high-risk venture and hesitate to give credit to commercial projects. Market limitations can also be either caused by a lack of consumer preference for the product or competition from fisheries products. Export-oriented projects have experienced the problem of adapting to export markets and their associated requirements (e.g. Hazard Analyis Critical Control Point (HACCP) surveillance). Balancing the difficulties of export (i.e. market knowledge) with the extra costs associated has been a severe hindrance for some countries.

Other constraints

Lack of specific aquaculture policy and legislation in many countries in the region causes difficulties in aquaculture development, investment and obtaining resources. Over-all need for a cohesive aquaculture policy, within the general development framework, is essential for future aquaculture development in the region. Such policies should promote aquaculture as an activity within the overall development objectives and should consist of enforceable laws and regulatory frameworks to support aquaculture and also to protect the environment.

There are many institutional constraints too. There is often weak cooperation among agencies that are concerned with aquaculture, which can lead to overlap or even conflict in their duties. Poor cooperation between the production and research interests, particularly for applied technology, the lack of farmers groups that are capable of presenting sectoral needs to official bodies, and insufficient extension services for the transfer of research to field application are also worth mentioning.

In a region such as the Near East, one cannot ignore the problem of natural constraints on aquaculture development. Most of these constraints relate to water availability and quality, but the characteristics of the land and the climate also need to be considered. These constraints are as follows:

- water scarcity is the foremost natural constraint, leading to competition with agriculture and other societal requirements;

- scarcity of appropriate land for development;
- competition with sectors, such as tourism, that leads to higher land prices can render coastal aquaculture unprofitable;

- decline in groundwater resources, due to over-pumping, affecting availability for aquaculture. In general, studies on the underground water reservoirs and their potential use in aquaculture appear to be largely insufficient.
- pollution of water resources, limiting use for aquaculture;
- harsh climatic conditions. The harsh climate in some countries can be a highly restrictive factor, especially in regard to water temperature, its intensity and daily or seasonal fluctuation (e.g. in Bahrain and Qatar).

Besides these, there are many constraints that are specific to different countries of the region.

Marketing of aquaculture products

Trade in fish and fishery products

Fish, shellfish and fishery products are integral within global trade, with no less than 195 countries having exported part of their production and some 180 countries having reported fishery imports in 1996. As production has increased, so international trade has continued to grow, accelerating in recent years. Part of this measured growth is linked to the expansion of the world's economies, but it also reflects the increased availability, owing mainly to aquaculture production, of consumer-desired species, as well as the sustained demand for fishmeal. Another part of the increase measured is nominal, since it is due to newly reported trade between countries that were formerly within one political entity.

FAO statistics reported export volumes reaching 22 million mt in 1996, which is nearly three times the volume traded in 1976. When reconverted into the estimated live weight equivalent, this represents 40 percent of total fisheries production, a rise from around 30 percent. The following section describes the characteristics and trends for the trade and

Government farms tend to auction their products well in advance of harvest, while private operators depend on daily prices and demand. Cage farms harvest on demand, usually selling direct to retail. At present, most, if not all of the aquaculture products are marketed locally.

Fish marketing is a business that is almost totally private. Fish marketing regulations are concerned mainly with the quality of the product, irrespective of whether its source is aquaculture or fisheries. Egypt also imports about 25 percent of the fish consumed in the country, imports being dominated by frozen pelagic fish. The main consumers of frozen products have low incomes.

Market supply and demand factors control prices and the higher value "luxury" species, which used to be exported, now command equal or higher values to those obtained on export markets. Consequently, producers are no longer interested in tackling the demanding procedures required for export. In addition, requirements such as those demanded by the EC regulations have greatly increased local preparation costs for export products. Most aquaculture products are treated by the same legislation as applied to fisheries.

Saudi Arabia

Farm-raised tilapia is well received by certain ethnic expatriates but, in general, the local population is less welcoming. Constant prices of 11 to 13 Saudi Riyal [approximately 4.0 US$) are obtained for the preferred product, fresh fish. Retail prices are some 30-50 percent higher, and well-established networks for retail sale in the major cities have been established. At present, demand appears to be increasing, and there is no major problem in marketing tilapia produced from aquaculture.

Turkey

The aquaculture market is clearly divided into two sections, trout for the domestic market and marine aquaculture for export. While the trout

marketing of aquaculture products for some of the countries in the Near East Region. Adequate data are not available for all countries of the region.

Marketing and trade patterns

Egypt

Sales and marketing characteristics vary following the type of culture and the location. If harvested and delivered to collection points, auction sale to wholesalers remains the dominant procedure, using cooperative staff for icing, sorting and weighing.

sector enjoyed prices much higher than seen elsewhere (e.g. in EC nations), these diminished as production increased to important levels. Investment in added-value products has given some benefit to counter this trend. The mariculture sector had depended quite considerably on export, particularly to the southern EC nations. The EC ban on imports created great disturbance and forced this subsector to invest in a national campaign, which provided beneficial results.

Cyprus

Cyprus has promoted offshore aquaculture activities, following the lack of suitable sheltered bays and conflicts with the tourism industry, which have allowed production to develop. Fish is supplied for national demands and the tourist sector, as well as for export. Export difficulties relate, as elsewhere, to entering a competitive market while being hindered by import taxes and adhesion to EC standards. A policy of diversification and technology application is being promoted in order to render the sector more competitive.

Trade, marketing and the future

There is a clear distinction within the Near East between aquaculture development that has been made for domestic consumption, either for import substitution or for improving national supplies, and that for export, where foreign exchange earnings appear as the key motivation for the activity. The progress in marine aquaculture, primarily for seabass and seabream, reflects the latter position, usually stimulated by private investment and, in some cases, through joint ventures made with European enterprises. The dangers of over-dependence on single markets, highlighted by specific experiences, combined with the absence of sectoral marketing actions has been quite notable. In many cases, where the sector has attained a higher degree of organization, notably through the creation of professional associations, national and international marketing actions have been achieved with very positive results.

Egypt

The aquaculture production sector in Egypt is composed of a minor public and a major private sector. Most private aquaculture activities are of a primitive form, and farmers tend to lack enough education in technical matters. Focus is on direct production costs, as opposed to sectoral development, and awareness of responsible aquaculture is weak. Fish farmers are keen to know more about the quality of water inputs and the environment within their farms, but effluent outflows and the potential for downstream pollution are of less interest. Time and effort will be required before this concept is accepted, and legal enforcement cannot guarantee the application of responsible aquaculture. However, the government can act as a positive contributor, through financing farm reforms or cancelling licenses or land-lease contracts. The government sector and well-developed aquaculture cooperatives and businesses are generally better developed, both technically and financially, where management understands the value of applying responsible aquaculture. Nonetheless, concern always exists for the higher costs anticipated in adapting to the principles. The government has applied a group of measures to prevent the negative effects of the growth of uncontrolled or irresponsible aquaculture. Among these provisions is a control measure for only licensing new farms or land-leases to projects that are environmentally friendly.

All aquaculture producers, including traditional fish farmers, are aware of the importance of monitoring water quality criteria for inflows, following problems with pollution from other

In the future, if private investment is to be stimulated and aquaculture expansion foreseen, more attention will need to be given to national actions that enable reinforcement of the markets instead of creating the more fragile dependence on single export markets.

Responsible aquaculture development: some case studies

The following section presents four cases concerning the concept and application of responsible aquaculture, noting the variations seen between individual countries. Overall, however, there is constancy in the negative attitude towards aquaculture from NGOs and sectors that share common resources, especially tourism.

Only farms located near the Red Sea or in protected areas receive the attention of the authorities and NGOs in regard to possible impacts on the environment.

Disease outbreaks are not common in Egyptian aquaculture, probably due to the practice of sun-drying ponds after harvest and the use of low stocking densities. On-farm surveillance is rather weak, and therapeutic advice is usually sought from public agencies and veterinary centres. The use of drugs or therapeutic agents is largely limited to the large-scale hatcheries and nurseries, whose effluents are discharged into the drainage systems. Mortalities are disposed of by incineration or burying, depending on the scope of the incident.

National development plans have been made within the region, due to the realisation of the importance of aquaculture for achieving food security and improving fish trade patterns. The plans vary in respect of short or long-term interests. Common elements exist, such as productivity increases and better resource use, while other issues differ following national interests.

A 15-year national plan was approved, integrating aquaculture within the concept of activities (farming, industry etc.). Economic interests tend to outweigh environmental awareness, and many farmers argue that aquaculture effluent is no worse than the agriculture drainage water used for water supply. Also, the comparison is held up that other sources of pollution are worse than the potential pollution their farms may cause, noting that chemicals or therapeutic agents are rarely used in Egyptian aquaculture.

The Ministry of Environmental Affairs operates a monitoring programme to assure that aquaculture activities are in compliance with environmental regulations. Regular analysis of water quality is done for the effluents of different activities (for example, flows into rivers, canals, drains and lakes). However, under national environmental legislation, fresh- and brackishwater aquaculture is not included within the activities that have a negative impact on the environment, and therefore, fish-farm effluents are not routinely examined.

The plan targets an increase in per capita fish consumption of 13 kg/yr, to be obtained primarily from increasing national fish production. A realistic evaluation of the capabilities and available opportunities for development was an integral consideration, and a review of national resources was made, including material and technical aspects. Providing secure job opportunities for national employment and maximizing the responsible use of all available resources are also core elements. The government developed the plan after extensive consultation with representatives of the private production sector, research and other relevant bodies and organizations. It should provide more opportunities for the private sector to develop investments and actions in intensive and semi-intensive fish farming.

The development plan has been successful in both promoting and developing aquaculture in Egypt. Besides the increase in fish production, a notable qualitative improvement has been seen in the production techniques applied, especially among the less developed farms. Historically, aquaculture was limited geographically to the northern delta; Upper Egypt is now sharing aquaculture development and with great success. The precautionary approach to development was adopted within the plan, so as

improving national fish resources. The main features of the plan are:

- encouraging fish farming development by giving security to farm projects, especially those on leased lands;
- encouraging investment in aquaculture;
- technical and action support for the upgrading of traditional farms;
- providing adequate supplies of healthy fry and fingerlings, at reasonable cost;
- improving handling and distribution of live fish;
- support for the establishment of hatcheries for Nile tilapia;
- production of fish feeds of improved dietary balance;
- encouraging investments in marine aquaculture and intensive fish farming;
- encouraging joint-venture aquaculture developments with partners from developed countries, particularly in mariculture; and
- encouraging integrated forms of aquaculture.

to avoid the anticipated negative effects of unplanned expansion on both water and land resources.

Saudi Arabia

Saudi Arabia possesses great potential for aquaculture development but, until recently, mariculture had been neglected and the expansion of inland aquaculture has been constrained by limited ground water availability. Since demand for seafood is increasing and the yield from capture fisheries has levelled off, requirements could be met from mariculture development and the improved integration of aquaculture with agriculture.

The annual water requirements of agriculture are 14 billion cubic metres and, if integrated with aquaculture before application to irrigation, considerable fish production could be achieved. Stocking the reservoirs of the Jizan, Najran and Abha regions, which hold and supply 1.85 billion cubic metres of water, could further increase the freshwater fish yield.

Diversification of aquaculture species is necessary, but the technology and seed supply for higher value species need to be made available to fish farmers. Such species include groupers, mullets, rabbitfish and penaeid shrimps. Given the scarcity of fresh water, the application of closed-system technology for water cleansing and recycling is needed. Well-defined research and development programmes are required, but there is enthusiasm for technological improvement and investment opportunities for products adapted to market demand.

Morocco

Directive plans for aquaculture development are in progress at the governmental level, but lack precision at present. While good developments are being made for the reestablishment of Mediterranean coastal waters with blue-fin tuna, a project made in cooperation with Japan, no other plans for mariculture development have been issued. The plan for inland aquaculture development (1996-1997) has two objectives:

- to increase production of fingerlings of brown trout, pike and black bass to stock

- In the Near East, water represents the most important item of the aquaculture planning process, simply because of its scarcity. In many cases, it is also almost impossible to modify the status of use, either in quantity or in quality. Adequate sharing of this vital resource with other activities has to be considered, so as to avoid direct competition with other sectors. All water sources need to be studied and assessed. Special attention should be given to the quality of water and whether it is really appropriate for aquaculture, noting potential changes during the growing season. Underground water should not be seen as an endless resource. These points affect the choice of aquaculture system to be applied. In countries that suffer water shortage, such as Jordan, extensive aquaculture systems could damage water availability. In Saudi Arabia, where underground water is used, integrated or intensive systems remain the systems of choice. In Egypt, only agricultural drainage water is allowed for aquaculture.

Good site selection is one of the most important factors in fish-farm planning. Awareness of the

for sport fisheries; and
- to increase carp fingerling supplies for control of the eutrophication seen in reservoirs and to increase commercial fisheries in dam waters.

Kuwait

With self-sufficient fish supplies being the objective, a strategy for developing the aquaculture sector was made by the Public Authority for Agriculture Affairs and Fish Resources (PAFAAFR), and this includes developing fish culture in the Gonna Kuwait area and in the low-salinity waters of the agricultural areas. Mariculture is being developed in sea cages at a commercial level, but efforts are being made to inform farmers of the main issues, risks and responsibilities of inland aquaculture. Native fish species are interesting candidates for development, but further research is required; non-native species whose culture technology has been established could also be incorporated into future planning.

Challenges and opportunities for aquaculture development in the region

The goals of a successful development plan must be realistic and should consider all of the different elements required for achievement. Although final goals and objectives may appear to be different, most of the core requirements are common to the planning process.

issues of competition and resource sharing is essential, while land and local climate suitability for aquaculture are indispensable attributes. Questions concerning the appropriateness of soil amendments, pond linings or appropriate cage technology are several of the issues that need to be assessed.

Water temperature ranges determine the type and species of fish and crustaceans that can be cultured. In some countries, both cold- and warmwater fish could be grown. In the case of Syria, attempts were made to raise tilapia in the warm period followed by trout during the colder period. Extreme temperature ranges can be very difficult for aquaculture to work with, with some areas ranging from sub-zero to >40 °C within the year. The use of appropriate infrastructure and management techniques is needed. Rainfall is another important factor to consider. Heavy rainfall can cause significant damage (for example, to ponds and dykes) while also affecting salinity regimes. High evaporation rates also affect performance, increasing the salinity of brackish waters, and need to be well considered in the planning of the production process.

Selection of the right species for the right conditions is critical for successful development. The appropriate criteria relating to growth, tolerance to site conditions and marketability must be met if the farmer is to be able to rear and sell the product. Seed and fingerling supply is an important issue throughout the region. Project promotion should not be made unless there are assured supplies from hatchery sources.

There are significant national and regional differences in consumer preference. For example, even though common carp was introduced into Egypt many years ago, local consumers prefer tilapia. While rabbitfish is a favoured species in Saudi Arabia, its market position in Egypt is much lower. For shrimps, the tiger shrimp is preferred for culture, while freshwater prawns encounter market resistance. Irrespective of the perceived economic value of species that are nominated for aquaculture, the choice should ideally be based on the nature of the environment selected for aquaculture, rather than trying to adapt the environment to the species.

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Aquaculture development in the region will greatly depend on the development of conducive national policies and formulation of enforceable regulatory frameworks. Such policies and regulatory frameworks should take into due consideration the role that aquaculture can play in overall national development, food security, poverty alleviation, trade and economic development. Research, education and extension will continue to play an important role in regional aquaculture development. Prioritization of research, national capacity building, institutional strengthening and other infrastructural development will be key factors in assuring success. Adequate participation of all concerned parties and stakeholders is important to ensure sustainable development and growth of the aquaculture sector in the Near East.

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[1] The Near East Region includes Algeria, Bahrain, Cyprus, Egypt, Iraq, Israel, Jordan, Kuwait, Lebanon, Libyan Arab Jamahiriya, Morocco, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Tunisia, Turkey, the United Arab Emirates and Yemen.

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[3] Libya refers to Libyan Arab Jamahariya