

**REGIONAL REVIEW ON AQUACULTURE DEVELOPMENT
2. NEAR EAST AND NORTH AFRICA – 2005**



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REGIONAL REVIEW ON AQUACULTURE DEVELOPMENT 2. NEAR EAST AND NORTH AFRICA – 2005

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FOREWORD

The world population is on the rise, as is the demand for aquatic food products. Production from capture fisheries at the global level is levelling off and most of the main fishing areas have reached their maximum potential. Sustaining fish supplies from capture fisheries will, therefore, not be able to meet the growing global demand for aquatic food.

At present, the aquaculture sector contributes a little over 40 million tonnes (excluding aquatic plants) to the world aquatic food production. According to recent FAO predictions, in order to maintain the current level of per capita consumption at the minimum, global aquaculture production should reach 80 million tonnes by 2050. Aquaculture has great potential to meet this increasing demand for aquatic food in most regions of the world. However, in order to achieve this, the sector (and aqua-farmers) will face significant challenges.

A major task ahead for sustainable aquaculture production will be to develop approaches that will increase the contribution of aquaculture to the global food supply. These approaches must be realistic and achievable within the context of current social, economic, environmental and political circumstances. Accurate and timely information on the aquaculture sector is essential in order to evaluate the efficacy of these approaches and how they can be improved.

Under the FAO Fisheries Department's current work programme, the Inland Water Resources and Aquaculture Service (FIRI) of the Fishery Resources Division, using a wide-ranging consultative process, regularly conducts reviews on the status and trends in aquaculture development (FAO Fisheries Circular No. 886 – Review of the State of World Aquaculture and FAO Fisheries Circular No. 942 – Review of the State of World Inland Fisheries). The last review (both regional and global) was conducted in 1999/2000 and was published following the Global Conference on Aquaculture in the Third Millennium held in Bangkok, Thailand, in 2000 (NACA/FAO, 2001, Aquaculture in the Third Millennium). These reviews are seen as important milestones and the documents produced are recognized as significant reference materials for planning, implementing and managing responsible and sustainable aquaculture development worldwide.

As part of this continuing process and with the current objective of preparing a global aquaculture development status and trends review, FIRI had embarked on a series of activities. These are:

- National Aquaculture Sector Overviews – NASOs;
- Prospective Analysis of Future Aquaculture Development – PAFADs;
- five regional workshops to discuss the status and trends in aquaculture development in Asia and the Pacific, Central and Eastern Europe, Latin America and the Caribbean, Near East and North Africa, and sub-Saharan Africa; and
- seven regional aquaculture development status and trends reviews in Asia and the Pacific, Central and Eastern Europe, Latin America and the Caribbean, Near East and North Africa, North America, sub-Saharan Africa and Western Europe.

This document presents the regional synthesis for the Near East and North Africa of all the information collected from the above activities.

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ABSTRACT

The Fisheries Department of the Food and Agriculture Organization of the United Nations (FAO) regularly conducts reviews of aquaculture status and trends, most recently in 2005. This regional review for the 17 countries in the Near East and North Africa is a synthesis of the available National Aquaculture Sector Overviews (NASOs) and Prospective Analyses for Future Aquaculture Development (PAFADs), with a focus on the period 1994–2003. The review process also included regional expert workshops held in Cairo (Egypt) and Muscat (Oman) in 2005, for discussion of the regional aquaculture development, in particular the status, trends and challenges. The information from these workshops is also included in this regional review. In the last decade, the sector has demonstrated remarkable growth from 96 700 tonnes in 1994 to 566 250 tonnes in 2003, and the contribution of aquaculture to total fisheries increased from 4.5 percent to 18.7 percent. Nearly all countries are expected to increase their aquaculture production, manifest in increased production tonnage and diversity of culture species. Production is dominated by Egypt and the Islamic Republic of Iran, with Bahrain, Kuwait, Oman, the United Arab Emirates and Yemen being emerging producers. In many instances, increases in production are driven by a need to increase reliability of the domestic supply. Production of protein for human consumption is dominant, particularly of finfish such as tilapia, carps and marine finfish species; the Indian white prawn is the only crustacean of significant economic importance. Within food fish production the main trends are increased culture of marine species, intensification, and more integrated agriculture-aquaculture. Within non-food species, the main trend is towards production of ornamentals. Successfully addressing four key priority issues is essential for the continued growth of aquaculture in the region: (i) farming systems, technologies and species; (ii) marketing and processing; (iii) health and diseases, and (iv) policies, legal frameworks, institutions and investment.

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ABBREVIATIONS AND ACRONYMS

DMR	Directorate of Marine Resources
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GAFRD	General Authority for Fish Resources Development
GCC	Gulf Cooperation Council
GDP	Gross Domestic Product
GMO	Genetically Modified Organisms
GNP	Gross National Product
IFO	Iranian Fisheries Organization
ISSCAAP	International Standard Statistical Classification of Aquatic Animals and Plants
MAF	Ministry of Agriculture and Fisheries
MOA	Ministry of Agriculture
MOF	Ministry of Fisheries
MRRC	Marine Resources Research Centre
NASO	National Aquaculture Sector Overview
NGO	Non-Government Organization
OIE	World Organisation for Animal Health (former denomination: International Office of Epizootics)
PAFAD	Prospective Analysis of Future Aquaculture Development
RECOFI	Regional Commission for Fisheries
UAE	United Arab Emirates
USA	United States of America

PART I

REGIONAL REVIEW ON AQUACULTURE DEVELOPMENT: NEAR EAST AND NORTH AFRICA – 2005

1. CHARACTERISTICS AND STRUCTURE OF THE SECTOR

Data sources: The information in this chapter has been extracted from the National Aquaculture Sector Overview (NASO) and Prospective Analysis of Future Aquaculture Development (PAFAD) documents submitted by the countries in the region, unless otherwise specified.

1.1 Overview of status and development

Aquaculture in this region has demonstrated remarkable growth in the last decade, from just over 96 700 tonnes in 1994 to approximately 566 250 tonnes in 2003, and values of about US\$235 million to US\$1 063 million, respectively. Furthermore, in the decade starting in 1994, the aquaculture contribution to total fisheries increased markedly from 4.5 percent to 18.7 percent. Nearly all countries are expected to increase their aquaculture production, which will be manifest in both increased production tonnage and diversity of cultured species. In many instances, efforts to increase production are driven by a need to increase reliability of the domestic seafood supply, particularly because of the declining capture fish landings.

Aquaculture in the region is dominated by production of protein for human consumption (primarily finfish, but also crustaceans). The most important species groups are: tilapias, carps, and a number of marine fish species. The only crustacean of significant economic importance at present is the Indian white prawn. Both endemic and introduced species play a key role.

Production of seed and fish for stocking is also undertaken, e.g. by Bahrain (which has identified this as a developmental goal), Egypt (with the regions oldest restocking programme, hatcheries currently produce more than 75 percent of the 75 million fish seeds used annually to restock lakes and the river Nile), Iran (Islamic Republic of), Kuwait, and the United Arab Emirates. In some cases, this production focus is in response to the availability of coastal regions which are suitable spawning and nursery grounds. Other uses of aquaculture fishes include biological weed control in irrigation and drainage (grass carp in Egypt), mosquito control (tilapia in Oman), and fish for animal feed (the Islamic Republic of Iran). Aquaculture production of non-food aquatic species is only a minor sector of aquaculture in the region, and principally constitutes ornamental fishes.

There has been a shift from a focus on freshwater and brackish aquaculture of finfish, to greater diversification of species, particularly exemplified by culture of marine finfish and crustaceans. Several emerging producer countries have identified culture of marine species as their goal. The incorporation of higher levels of technology and knowledge in aquaculture practice, are leading to more sophisticated technical approaches.

1.2 Regional demographic and economic overview

The 17 countries in the region have a total land area of approximately 11 230 000 km², and a total population of approximately 280 million inhabitants. The countries range greatly in size and population: Algeria is the largest (nearly 2.6 million km²) and Bahrain is the smallest (approximately 700 km²); Iran (Islamic Republic of) the most populous (approximately 80 million inhabitants) and Qatar is the least populous (approximately half a million inhabitants). Across the region, population density ranges from approximately 850 inhabitants/km² in Bahrain to less than 3.8 inhabitants/km² in Libya; most countries have a population density of between 30 and 77 inhabitants/km².

1.3 Brief history of production and main developmental landmarks

Aquaculture has been known in some parts of this region since the beginning of written history, as evidence by the 2500 BC tomb frieze in Egypt showing the harvest of tilapia from ponds. Although some forms of traditional freshwater aquaculture have been practiced for many years in the region, development and expansion of modern aquaculture has taken place relatively recently, since the 1980s, in the major producing countries of Egypt and Iran (Islamic Republic of), and smaller producer countries such as the Syrian Arab Republic. Modern aquaculture is still in its infancy in emerging producer countries such as Bahrain, Kuwait, Oman, the United Arab Emirates (UAE) and Yemen.

In many countries, the initial impetus for recent aquaculture development was provided by national government programmes, providing hatcheries and experimental research stations, sometimes supplemented with international support, including that of the Food and Agriculture Organization of the United Nations (FAO) and donor governments active in the region. After initial start-up, some governments have continued to support the sector by providing fish (often as fingerlings), loans and sites, licensing, encouraging local and foreign investment, and provision of extension services. Subsequently, private investment has played a key role in a number of countries.

1.4 Land use and diversity of systems

Within the Near East and North Africa region, the total area under aquatic production is estimated to be 635 000 ha (Table 1.1). The greatest area under aquaculture production, 476 086 ha, is in Iran (Islamic Republic of), the second largest producer in the region. The next greatest area under aquaculture production, 87 404 ha, is in Egypt, the largest producer in the region. In Egypt, combined aquaculture-agriculture is of growing importance, and this occupies an additional 13 066 ha (Table 1.1). The average yield of the main production system (intensive pond farming) in the major producer (Egypt) was 17.5–30 tonnes/ha/year.

Table 1.1 Estimated area under aquatic production (ha)¹. *Data sources:* NASOs and PAFADs.

Country	Land-based	Coastal + Marine	Total
Egypt	na	na	87 404
Iran (Islamic Republic of)	na	4 100	476 086
Libyan Arab Jamahiriya	42	0	42
Morocco	24	15 238	15 262
Saudi Arabia	302	17 447 + 5 232	22 981
Syrian Arab Republic	889	0	889
Tunisia	18 000	1 395	19 435
TOTAL (8 countries)	–	–	622 099
TOTAL (est. for 17 countries) ²	–	–	635 000

Abbreviations (**na**) not available.

¹ Estimate made from eight countries providing detailed data.

² Total area under aquatic production for seven countries (Egypt, the Islamic Republic of Iran, Libyan Arab Jamahiriya, Morocco, Saudi Arabia, Syrian Arab Republic and Tunisia) is 622 099 ha. These countries contributed a total of approximately 98 percent of the tonnage of regional production in 2003 (see Table 2.1). Assuming that the area under production is related to the tonnage of production, an estimate of total area under aquatic production for 100 percent of the production tonnage is 635 000 ha.

Within the region, many different aquaculture systems are practiced, from extensive to semi-intensive and intensive. Holding facilities range from land-based culture to sea cages. The greatest diversity of systems are seen in the countries with the greatest variety of geography and weather conditions, such as Iran (Islamic Republic of), which supports aquaculture activities as diverse as warm water culture of Chinese carp, coldwater culture of rainbow trout, and coastal shrimp culture.

In some countries, integrated agriculture-aquaculture is practiced, most commonly involving tilapia, for example in Egypt, Kuwait, Libyan Arab Jamahiriya, Oman, Saudi Arabia, and the United Arab Emirates. In Oman, tilapia were initially introduced for control of mosquitoes in freshwater, and subsequently have been taken by local people into their farms for rearing.

2. PRODUCTION, SPECIES AND VALUES

Note on data sources: *In order to assemble data for all 17 countries in the region, it was necessary to use the data regularly submitted by the individual FAO Member Countries, since country profiles (NASOs) specifically requested for preparation of this regional review were not available for Jordan and Iraq. The data used herein was obtained directly from: (i) FAO Fishery Information Data and Statistics Unit (2005) Aquaculture production: quantities 1950–2003, and (ii) FAO Fishery Information Data and Statistics Unit (2005) Aquaculture production: values 1984–2003. The most recent comprehensive data is that for the year 2003, and temporal trends for the last decade presented here are derived from comparison of data for 1994 and 2003.*

It should be further noted that a number of countries have recently provided updated values for 2003 production tonnages, and this new data is given in Appendix. The updated information does not change the balance of activities within the region from that reported here, which is – as noted above – based upon the statistics annually submitted to FAO. However, for individual countries, the updated information in Appendix may show greater or lesser production than that in the official statistics.

2.1 Regional overview

Aquaculture production increased approximately five fold between 1994 and 2003, from about 96 700 tonnes in 1994 to approximately 566 250 tonnes in 2003. This represents a 21.7 percent annual growth rate over the period. The total (farm-gate) value of aquaculture production increased approximately four fold in the same period, from US\$235 million in 1994 to US\$1.06 billion in 2003 (Table 2.1).

Across the region, aquaculture contributed 18.7 percent of total fisheries production in 2003 (the year for which the most recent data is available) (Table 2.2). This value is a result of the significantly increasing contribution of aquaculture to total fisheries production in the region during the decade prior to 2003. A rapid increase in both the amount of aquaculture production and its contribution to total fisheries production began in 1995 (Figure 2.1). From 1984 to 1994, aquaculture contributed only 4–6 percent to total fisheries production.

2.2 Country overview

Current situation: Regional production is lead by Egypt, which produced about 445 200 tonnes of aquaculture products in 2003, accounting for 79 percent of the total regional production of approximately 566 250 tonnes. The second major producer country is Iran (Islamic Republic of), which produced slightly over 91 700 tonnes in 2003, accounting for 16 percent of total regional production. The remaining 15 countries together produced about 29 000 tonnes in 2003, accounting for 5 percent of the total aquaculture production (Table 2.1).

When the monetary value of aquaculture production is considered, a similar regional pattern is seen. Egyptian production accounted for 58 percent of the total value of regional aquaculture products of US\$1.063 billion in 2003, while the Iranian production accounted for 26 percent of the total value. The remaining countries together produced 16 percent of the value, led by Saudi Arabia and the Syrian Arab Republic with 7 and 6 percent, respectively (Table 2.1).

Table 2.1 Aquaculture production (tonnes) and value (US\$1 000) from 17 countries in the Near East and North Africa for 1994 and 2003. *Data sources:* FAO Fishery Information, Data and Statistics Unit (2005): Aquaculture production: quantities 1950–2003; and FAO Fishery Information, Data and Statistics Unit (2005): Aquaculture production: values 1984–2003.

Country	Production (tonnes) and regional share (%)				Production annual growth	Value (US\$1 000) and regional share (%)			
	1994 (tonnes)	1994 (%)	2003 (tonnes)	2003 (%)	1994–2003 (%)	1994 (US\$)	1994 (%)	2003 (US\$)	2003 (%)
Algeria	389	<1	476 ¹	<1	2.3	960	0.4	1 283 ¹	0.1
Bahrain	–	–	3 #	<1	E	0	–	8	<0.1
Egypt	56 603	59	445 181	79	25.8	103 432	44.1	615 011	57.9
Iran (Islamic Republic of)	25 899	27	91 714	16	15.1	68 227	29.1	273 855	25.8
Iraq	4 100	4	1 500	<1	-10.6	11 480	4.9	4 500	0.4
Jordan	86	<1	650	<1	25.2	402	0.2	2 292	0.2
Kuwait	–	–	195	<1	E	0	–	1 229	0.1
Lebanon	200	<1	790	<1	16.5	1 000	0.4	2 361	0.2
Libyan Arab Jamahiriya	30	<1	380	<1	32.6	135	0.1
Morocco	1 463	2	1 538	<1	0.6	11 014	4.7	4 726	0.4
Oman	–	–	352	<1	E	0	–	1 738	0.2
Qatar	–	–	0	0	E	0	–	0	–
Saudi Arabia	2 235	2	11 824	2	20.3	9 012	3.8	76 180	7.2
Syrian Arab Republic	4 521	5	7 217	1	5.3	21 645	9.2	62 329	5.9
Tunisia	1 137	1	2 130	<1	7.2	7 548	3.2	10 182	1
United Arab Emirates	–	–	2 300	<1	E	0	–	6 900	0.6
Yemen	–	–	0	0	E	0	–	0	–
TOTAL	96 663	–	566 250	–	21.7	234 855	–	1 062 594	–

1: The values indicated for Algeria are 2002 figures.

Symbols used in production tonnage columns: (–) no production; (0) some production, but <0.5 tonne; (...) data not available.

Other symbols: (#) production from government experimental mariculture centre, and not private commercial farms; (E) emerging producer, with very recent or imminent commercial production, therefore temporal changes in last decade cannot be calculated.

Table 2.2 Aquaculture and capture fisheries production along with the share of aquaculture from fisheries production in 17 countries in the Near East and North Africa in 1994 and 2003. *Data sources:* FAO Fishery Information, Data and Statistics Unit (2005): Aquaculture production: quantities 1950–2003; and FAO Fishery Information, Data and Statistics Unit (2005): Aquaculture production: values 1984–2003.

Country	Aquaculture production (tonnes)		Capture fishery production (tonnes)		Aquaculture share of fisheries production per country (%)	
	1994	2003	1994	2003	1994	2003
Algeria	389	476	135 410	141 528	0.3	0.3
Bahrain	-	3	7 628	13 638	0.0	0.0
Egypt	56 603	445 181	311 602	430 809	15.4	50.8
Iran (Islamic Republic of)	25 899	91 714	308 101	349 121	7.8	20.8
Iraq	4 100	1 500	25 147	21 600	14.2	6.5
Jordan	86	650	410	481	17.3	57.5
Kuwait	0	195	7 752	5 900	0.0	3.2
Lebanon	200	790	2 237	3 898	8.2	16.9
Libyan Arab Jamahiriya	30	380	33 513	33 666	0.1	1.1
Morocco	1 463	1 538	759 687	896 262	0.2	0.2
Oman	-	352	118 572	138 481	0.0	0.3
Qatar	-	0	5 086	11 000	0.0	0.0
Saudi Arabia	2 235	11 824	54 612	52 929	3.9	18.3
Syrian Arab Republic	4 521	7 217	5 520	8 911	45.0	44.7
Tunisia	1 137	2 130	85 645	90 341	1.3	2.3
United Arab Emirates	0	2 300	108 600	95 150	0.0	2.4
Yemen	0	0	81 885	159 000	0.0	0.0
Total	96 663	566 250	2 051 407	2 452 715	4.5	18.7

Symbols: (–) no production; (0) some production, but < 0.5 tonne.

Both parameters, production and value, show that aquaculture production is very unevenly practiced among the 17 countries of the Near East and North Africa region, with Egypt in a leadership position; thus, discussion of trends at the regional level (for example, concerning the species under culture) will be heavily determined by the situation in Egypt.

Temporal trends: In the decade from 1994 to 2003, most countries showed an annual growth in production. Annual growth in production was over 32 percent for Libyan Arab Jamahiriya and 20–25 percent in Egypt, Jordan and Saudi Arabia (25, 25 and 20 percent, respectively), 15–20 percent in Lebanon and Iran (Islamic Republic of) (16 and 15 percent, respectively), and 1–10 percent in Tunisia, the Syrian Arab Republic, Algeria and Morocco (7, 5, 2 and 1 percent, respectively) (Table 2.1). For Iraq changes in aquaculture production in the same decade are less comprehensively documented, but estimated to be -10.6 percent.

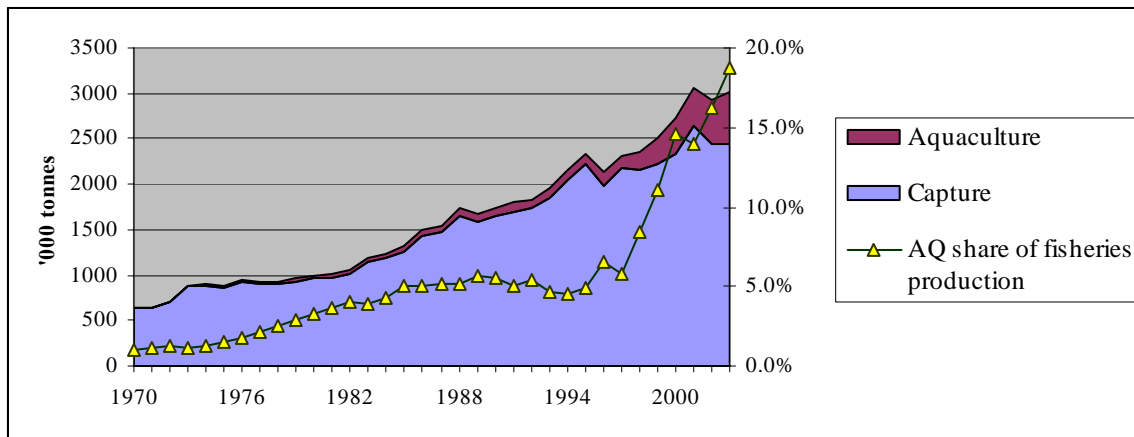


Figure 2.1 Contribution of aquaculture to total fisheries production in the region, 1970–2003.

Data sources: FAO Fishery Information, Data and Statistics Unit (2005): Aquaculture production: quantities 1950–2003; and FAO Fishery Information, Data and Statistics Unit (2005): Aquaculture production: values 1984–2003.

Three countries began commercial aquaculture production in the decade 1994–2003, namely Bahrain, Oman, Qatar and the United Arab Emirates (Table 2.1). Kuwait began commercial production just prior to this decade in 1992. Qatar and Yemen began commercial production just after this decade; Qatar began production in 2004 and Yemen began shrimp production in 2005.

In 1994, regional production was also lead by Egypt (59 percent of tonnage), followed by Iran (Islamic Republic of) (27 percent of tonnage). The remaining 9 countries with commercial production each produced 5 percent or less of the regional tonnage (Table 2.1). The temporal changes in production within individual countries and within the region greatly affected the share of the monetary value of regional aquaculture that was attributable to each country (Table 2.1). Of particular note was that the major producer, Egypt, contributed 44 percent of the value in 1994 and this jumped to 58 percent in 2003.

2.3 Species and species groups: food species

Production in the region is dominated by finfish, which account for nine of the ten most important species by volume; the Indian white prawn (*Penaeus indicus*) is the only crustacean of significant economic importance in the region at present. Nile tilapia had the largest production volume in the Near East and North Africa region with annual production of over 200 000 tonnes, followed by the Flathead grey mullet with 136 000 tonnes, and three species of carps (Table 2.3). The flathead grey mullet showed the largest value for 2003 at US\$261 million followed by Nile tilapia at US\$237 million, and the Indian white prawn at US\$113 million (Table 2.3).

Since production may not be reported to the species level, it is instructive to examine production and values in terms of aggregated groups of species. When ISSCAAP (International Standard Statistical Classification of Aquatic Animals and Plants) species groups are considered (see Table 2.4), the groups with the highest production are tilapias (206 267 tonnes), carps (172 142 tonnes) and miscellaneous coastal fishes (144 839 tonnes). The latter group includes the flathead grey mullet as well other relatively high-valued species like the gilthead seabream (*Sparus aurata*) and sobaity seabream (*Sparidentex hasta*) and the European seabass (*Dicentrarchus labrax*).

Table 2.3 Most important species in aquaculture production volume and value in 2003 (species with production >1 000 tonnes). *Data sources:* FAO Fishery Information, Data and Statistics Unit (2005): Aquaculture production: quantities 1950–2003; and FAO Fishery Information, Data and Statistics Unit (2005): Aquaculture production: values 1984–2003.

English common name	Scientific name	Volume (tonnes)	Volume (rank)	Value (US\$1 000)	Value (rank)
Nile tilapia	<i>Oreochromis niloticus</i>	201 973	1	237 374	2
Flathead grey mullet ¹	<i>Mugil cephalus</i>	135 945	2	260 946	1
Grass carp (=White amur)	<i>Ctenopharyngodon idellus</i>	93 122	3	105 225	4
Silver carp	<i>Hypophthalmichthys molitrix</i>	38 141	4	94 961	5
Common carp	<i>Cyprinus carpio</i>	37 050	5	82 037	6
Rainbow trout	<i>Oncorhynchus mykiss</i>	23 888	6	71 764	7
Indian white prawn	<i>Penaeus indicus</i>	16 622	7	113 472	3
Gilthead seabream	<i>Sparus aurata</i>	4 488	8	19 169	10
Tilapias nei	<i>Oreochromis</i> (=tilapia) spp.	4 114	9	33 771	8
Bighead carp	<i>Hypophthalmichthys nobilis</i>	3 665	10	9 163	11
European seabass	<i>Dicentrarchus labrax</i>	3 398	11	15 163	9

¹ The production volume and value indicated refers to the three species of mullets produced in Egypt. Under the FAO statistics these values are indicated under one species.

When value of production is considered, these three groups are also the most important, although their order of precedence is reversed as shown in Table 2.4. From the financial view point, miscellaneous coastal fishes are the most important species group in the Near East and North Africa region (approx. US\$298 800) followed by carps (approx. US\$291 500) and tilapias (approx. US\$271 700) (Table 2.4).

Table 2.4 Top species groups (ISSCAAP) in terms of aquaculture production in 2003; ISSCAAP= International Standard Statistical Classification of Aquatic Animals and Plants (species groups with production more than 100 tonnes). *Data sources:* FAO Fishery Information, Data and Statistics Unit (2005): Aquaculture production: quantities 1950–2003; and FAO Fishery Information, Data and Statistics Unit (2005): Aquaculture production: values 1984–2003.

ISSCAAP group	Volume (tonnes)	Volume (rank)	Value (US\$1 000)	Value (rank)
Tilapias and other cichlids	206 267	1	271 721	3
Carps, barbels and other cyprinids	172 142	2	291 513	2
Miscellaneous coastal fishes	144 839	3	298 832	1
Salmons, trouts, smelts	23 888	4	71 764	5
Shrimps, prawns	16 622	5	113 472	4
Miscellaneous freshwater fishes	1 287	6	11 557	6
Oysters	230	7	505	9
Tunas, bonitos, billfishes	196	8	1 764	7
Mussels	149	9	215	10
River eels	104	10	799	8

The production of Nile tilapia in Egypt was 199 557 tonnes in 2003. This one species item represents over 35 percent of the total production for the region. When the production from Egypt is excluded, the top three species groups in terms of production for the rest of the region are carps (approx. 66 700 tonnes), trout (approx. 24 000 tonnes) and shrimp and prawns (approx. 166 200 tonnes). The

latter two groups, trout and shrimp/prawn, showed particular growth in the last decade. At present all species farmed in the region are conventional, there are no Genetically Modified Organisms (GMO).

2.4 Non-food aquatic species

Non-food aquatic species are a minor part of aquaculture production in the region, and will probably remain so in the near future (Table 2.5). Non-food aquatics are raised in seven countries: Algeria, Egypt, Iran (Islamic Republic of), Libyan Arab Jamahiriya, Morocco, Saudi Arabia and the Syrian Arab Republic, and in each of these countries production of these products is low compared to food species.

Iran (Islamic Republic of) shows the greatest potential for diversifying and increasing its production of non-food species, with pilot projects having demonstrated the feasibility of farming seaweed (*Gracilaria* spp.), oyster seed (for Persian Gulf pearls, natural pearl oyster stock having been overfished to a critical position) and *Artemia*. The Islamic Republic of Iran is the most significant producer of ornamental fish in the region, currently raising some 85 species worth US\$290 million, and employing 833 people.

Algeria is in the start up phase of production of ornamentals, and presently has a hatchery and government support for this segment of the industry. In Egypt, there are two small farms raising crocodiles for their skin, and the first license for an ornamentals farm was issued in 2005. In Libyan Arab Jamahiriya and Morocco, there is small scale production of ornamentals. In Saudi Arabia, the currently small-scale ornamental fish production is destined for development, in order to reduce the reliance on imports. In the Syrian Arab Republic, there are four ornamental farms, producing some 440 000 fish per year.

Table 2.5 Aquaculture production of non-food aquatic species. *Data sources: NASOs and PAFADs.*

Country	Seaweeds	Reptiles	Pearl	Ornamental fish	Other
Algeria	–	–	–	+	–
Egypt	–	Crocodiles	–	+	–
Iran (Islamic Republic of)	+	–	+	+	<i>Artemia</i>
	<i>Gracilaria</i>				
Libyan Arab Jamahiriya	–	–	–	+	<i>Gambusia</i> or Mosquitofish
				small scale	
Morocco	–	–	–	+	–
Saudi Arabia	–	–	–	+	–
				small scale	
Syrian Arab Republic	–	–	–	+	–

2.5 Culture environments

Among the three culture environments, namely freshwater, brackish water, and marine waters, the greatest tonnage of aquaculture production (72 percent) comes from brackish water (Figure 2.2A). This is attributable to the dominance of brackish water culture in Egypt (394 540 tonnes of the 404 259 tonnes for the region), most of which is semi-intensive culture of (tilapia). If regional production, excluding Egypt, is examined, the greatest tonnage of aquaculture production (81 percent) comes from freshwater (Figure 2.2B).

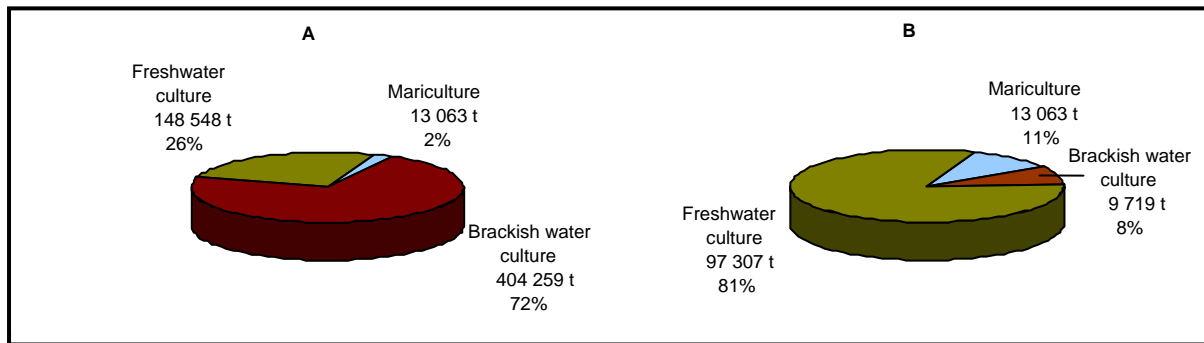


Figure 2.2 (A) Aquaculture production by culture environment in the Near East and North Africa region (all countries) in 2003 and (B) by culture environment (excluding Egypt) in 2003. *Data sources:* FAO Fishery Information, Data and Statistics Unit (2005): Aquaculture production: quantities 1950–2003.

3. ECONOMICS AND TRADE

Data sources: The information in this chapter has been extracted from the NASOs and PAFADs submitted by the countries in the region unless specified.

3.1 Contribution of aquaculture to national economies

Within the region, fisheries (including aquaculture) generally make a small contribution to national economies, when assessed by percentage of Gross Domestic Product (GDP). Few countries have started to differentiate in their trade statistics whether fish are of farmed or wild origin, and thus for most countries the specific contribution of the aquaculture sector to GDP and Gross National Product (GNP) cannot be assessed.

The percentage contribution of fisheries (capture fishery and aquaculture combined) to GDP is generally low for the countries of the Near East and North Africa, for example: Bahrain 0.23, Egypt 1.4, Islamic Republic of Iran 0.23, Kuwait 0.07, Oman negligible, Qatar 0.03, Saudi Arabia 0.04, Syrian Arab Republic 0.03, Tunisia 1.12, United Arab Emirates <0.1, Algeria and Yemen negligible. Thus the countries can be grouped into those with a contribution of >1 percent, Egypt, Tunisia; a contribution of 0.1–1 percent, Bahrain, Islamic Republic of Iran; and those with a contribution of <0.1 percent, Kuwait, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, United Arab Emirates and Yemen. In case of Morocco the percentage contribution of fisheries (capture fishery and aquaculture combined) to GDP is in the range of 3 percent mainly due to the importance of the capture sector.

3.2 Export and import

Eleven countries export their aquaculture products, namely Bahrain, Egypt, Islamic Republic of Iran, Kuwait, Lebanon, Libyan Arab Jamahiriya, Morocco, Oman, Saudi Arabia, Tunisia and the United Arab Emirates. A wide range of products are exported including market size food fish and shellfish; fish fingerlings; supplies, principally fish feed; and non-food aquatics. Across the region, there is a great variation in the degree of reliance on the export market, for example in Libyan Arab Jamahiriya virtually all production (90 percent) is exported, whereas in Egypt there is currently very little export.

The largest regional producer, Egypt, has not historically been a significant exporter, because of very high domestic demand for its aquaculture products. Egypt intends to begin export in the near future (2006). For the region's second largest producer, Iran (Islamic Republic of), income generation from aquaculture exports is expected to increase, both in absolute and relative terms (the country is showing strong annual growth in aquaculture production, and anticipates an increase in export of

fisheries products relative to agricultural products). For the regions third largest producer, Saudi Arabia, exports are expected to increase, due to recent improvement in communications and cargo services, facilitating export to important European markets. Among the smaller regional producers, including those that are just beginning commercial production, exports will also be important – both within and beyond the region.

Market-size fish are exported by the Islamic Republic of Iran, Libyan Arab Jamahiriya, Morocco, Oman, Tunisia and the United Arab Emirates; Egypt exports a negligible amount of fish at present. Most exported food fish are destined for markets within the Near East and North Africa region (Table 3.1), and some products are also exported to more distant markets in Europe, Canada, the United States of America and Japan. A diversity of species and fish products are exported including tilapia, seabass, seabream, mullet, tuna, trout, caviar and shrimp. Most fish are exported as fresh, but some filleted products are also traded. The most important species group for export is the miscellaneous coastal fishes from Libyan Arab Jamahiriya, Egypt and Tunisia; Morocco, export to the European Union mainly gilthead seabream and European seabass; Oman, export to the United Arab Emirates, mainly European seabass, gilthead seabream, mullet, yellowfin seabream and spinycheek grouper; from Tunisia exports to Europe (mainly France, Germany, Italy and Switzerland) market-size European seabass and gilthead seabream; and from the United Arab Emirates, export to Europe (England, France, Germany, Spain, Switzerland, Yugoslavia), USA and Canada, are mainly gilthead seabream, European seabass and the sobaity seabream. The region second largest producer, Iran (Islamic Republic of) exports mostly caviar and shrimp.

Table 3.1 Destination of exported farm-raised market size seafood within the region¹. *Data sources: NASOs and PAFADs.*

Exported from ↓ to →	Algeria	Bahrain	Egypt	Iran (IR)	Iraq	Jordan	Kuwait	Lebanon	Libya (AJ)	Morocco	Oman	Qatar	Saudi Arabia	Syria (AR)	Tunisia	UAE	Yemen
Egypt	t ²	-	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iran (Islamic Rep.)	-	c,s	-	na	cy	-	c,s	-	-	-	-	c,s	-	-	-	-	-
Libyan Arab Jama.	-	-	c	-	-	-	-	-	na	-	-	-	-	-	c	-	-
Oman	-	-	-	-	-	-	-	-	-	-	na	-	-	-	-	c	-
UAE	-	-	-	-	-	c	c	c	-	-	c	-	c	c	-	na	-

Abbreviations for ISSCAAP species groups: (c) miscellaneous coastal fishes; (cy) cyprinids; (m) mussels; (tr) trout; (s) shrimp and prawns; (t) tilapias; (tu) tuna; (-) no export; (na) not applicable.

¹Exports outside the region are from Morocco and Tunisia to Europe, and the United Arab Emirates to Europe, USA and Canada. Egypt will soon begin exports to Europe.

²Negligible amount (approximately 0.5 tonne).

Fry and fingerlings are exported by Bahrain, Egypt, Kuwait, with most of the exported products destined for other countries within the region (Table 3.2). The region, however, is not yet self sufficient in fry and fingerling resources, and supplementary supplies of several species of commercially important finfish are imported from Europe (France, Greece and Italy – mainly European seabass and gilthead seabream), and rainbow trout (mainly eyed eggs) and carp are imported from Denmark, Yugoslavia and the USA (Table 3.3). Fish feed is exported by only three countries, Egypt, Saudi Arabia and United Arab Emirates, and most countries need to import feed from within and beyond the region (refer to section 5.2 on feed resources for additional information).

Table 3.2 Destination of exported farm-raised seed, fry and fingerlings within the region. *Data sources: NASOs and PAFADs.*

Exported from ↓ to →	Algeria	Bahrain	Egypt	Iran (IR)	Iraq	Jordan	Kuwait	Lebanon	Libya (AJ)	Morocco	Oman	Qatar	Saudi Arabia	Syria (AR)	Tunisia	UAE	Yemen
Bahrain	-	na	-	-	-	-	-	-	-	-	-	-	-	-	-	c	-
Egypt	t	-	na	-	-	t,c	t	t	s,r	t	-	-	t,c	-	cy	t,c	t
Kuwait	-	-	-	-	-	-	na	-	-	-	c	-	-	-	-	c	-

Abbreviations for ISSCAAP species groups: (c) miscellaneous coastal fishes; (cy) cyprinids; (m) mussels; (tr) trout; (s) shrimp and prawns; (t) tilapias; (tu) tuna; (-) no export; (na) not applicable.

Table 3.3 Sources of imported eggs, juveniles and broodstock from within and outside the region. *Data sources: NASOs and PAFADs.*

Importing country ↓ Source →	Sources within the region	Sources outside the region
Algeria	Egypt (tilapia: j , b)	Hungary (carp spp.: j , b ; pike-perch: j , b ; barbel: j , b)
Bahrain	-	France (gilthead seabream: e , j)
Iran (Islamic Republic of)	-	European Union
Kuwait	Bahrain (sobaity seabream: j)	France (gilthead seabream: e) Greece (gilthead seabream: e)
Lebanon	-	Denmark (rainbow trout: e) South Africa (rainbow trout: e) USA (rainbow trout: e)
Libyan Arab Jamahiriya	-	South Africa (tilapia: b) Malta (European seabass: b ; gilthead seabream: b) France, Italy, Spain (European seabass: e , j ; gilthead seabream: e , j)
Morocco	Egypt (tilapia: j)	-
Oman	Bahrain (sobaity seabream: j) Kuwait (gilthead seabream: j ; yellowfin seabream: j ; spiny-cheek grouper: j)	France (gilthead seabream: j)
Qatar	Bahrain (sobaity seabream: j ; silver seabream: j ; rabbitfish: j)	-
Syrian Arab Republic	-	Egypt (carp: ?) Korea Republic (grass carp: ?) Belgium (rainbow trout: e) Hungary (grass, silver, common carps: j)
Tunisia	-	Italy (European seabass: j ; gilthead seabream: j)
United Arab Emirates	Bahrain (sobaity seabream: j ; European seabass: j) Kuwait (gilthead seabream: j ; European seabass: j)	France, Greece (gilthead seabream: j ; European seabass: j)

Abbreviations: (e) eggs; (j) juveniles; (b) broodstock; (?) information unknown.

The principal non-food aquatic species of commercial importance in the region are ornamental fish, which are raised in seven countries, Algeria, Egypt, Iran (Islamic Republic of), Libyan Arab Jamahiriya, Morocco, Saudi Arabia and the Syrian Arab Republic (Table 3.4). They are imported from outside the region, and exported within the region, to Jordan and Libyan Arab Jamahiriya. For Egypt, the export market for locally bred, imported freshwater ornamentals is growing rapidly.

Table 3.4 Imports and exports of ornamental fish from the Near East and North Africa region.

Data sources: NASOs and PAFADs.

Country	Imports from	Export to
Algeria	Outside the region (Southeast Asia, Russia and Europe)	France
Egypt	Outside the region	Jordan; Libyan Arab Jamahiriya
Iran (Islamic Republic of)	nd	nd
Libyan Arab Jamahiriya	Egypt; Outside the region	–
Morocco	Outside the region	Outside the region
Saudi Arabia	nd	nd
Syrian Arab Republic	Thailand; Singapore	Jordan

Abbreviation: (nd) no data.

3.3 Labelling, permits and certification

Countries within the region exhibit a great heterogeneity in the extent of labelling (traceability), permits and certification that apply to their aquaculture products and supplies. This heterogeneity does not appear related to volume of aquaculture production, or to duration of establishment of commercial aquaculture.

Labelling of market sized fish to provide traceability, is presently practiced in less than half of the countries in the Near East and North Africa region, namely Algeria, Iran (Islamic Republic of), Morocco, Oman, United Arab Emirates and Yemen. In some of the other countries, the need for labelling and traceability has not been crucial as there has been no export of their market sized fish; such has been the case for Algeria, Egypt and the Syrian Arab Republic. However, in preparation for imminent export of some aquaculture products, Egypt will soon begin a labelling programme.

Regulation, via permits and/or certification, for export of market size fish, and for export and import of fish eggs, juveniles and broodstock is in place in most of the countries in the region (Table 3.5). However, some countries have less comprehensive regulation in place, including Iraq, Qatar, United Arab Emirates and Yemen; the latter three are emerging producer countries. Regulations affecting shellfish are found in fewer countries than are regulations affecting finfish, reflecting the fact that only few countries in the region are shellfish producers. However within the shellfish producer countries, there are regulations in place for export of market size product and export of seed.

For several countries in North Africa, such as Morocco and Tunisia, the need to comply with strict European Union (EU) regulations for fish and shellfish is key to their existing export market. Morocco was the first country in North Africa to export mariculture products, has its own labelling and certification approved by the EU, and is allowed to export its aquaculture products to EU member countries. For Tunisia, the same certification procedures are used for the quality of market size fish as are used in the EU. Egypt is adopting and applying the regulation on safety and quality control introduced by the EU, and this will be essential for the emerging export sector of aquaculture in Egypt.

For countries in the Near East, complying with EU standards can also open up export markets. For example, in Saudi Arabia, cultured shrimp is the most important species in terms of volume and value. Prime shrimp has previously been exported to Japan, Australia and the USA. Recently, export to the EU has begun, following EU approval of quality and safety standards.

Table 3.5 Regulation (permits and/or certification) for export and import for finfish and shellfish products¹. *Data sources: NASOs and PAFADs.*

Country	Finfish						Shellfish				Notes	
	Market-size	Eggs		Juveniles		Broodstock		Market-size		Seed		
	Ex	Ex	Im	Ex	Im	Ex	Im	Ex	Im	Ex		Im
Algeria	+	+	+	+	+	+	+	+	+	+	?	--
Bahrain	-	+	+	+	+	+	+	na	+	na	na	--
Egypt	+	+	+	+	+	+	+	+	+	na	?	--
Iran (Islamic Rep.)	-	+	+	+	+	+	+	+	+	na	?	--
Iraq	-	?	-	?	-	-	-	?	-	-		--
Lebanon	?	?	+	?	+	?	+	?	?	?	?	--
Libyan Arab Jama.	?	na	+	na	+	?	+	na	na	na	na	--
Morocco	+	+	+	+	+	+	+	+	+	?	+	--
Oman	+	+	+	+	+	+	+	+	+	+	?	2
Qatar	-	-	-	-	+	-	+	-	+	-	na	--
Saudi Arabia	+	+	+	+	+	+	+	+	+	+	?	--
Syrian Arab Rep.	+	na	+	+	+	na	+	+	+	na	+	--
Tunisia	+	+	+	+	+	+	+	+	+	+	?	3
UAE	+	+	+	-	+	-	+	-	-	-	?	4
Yemen	+	-	-	-	-	-	-	p	-	-	?	--

Abbreviations and symbols: (**Ex**) export; (**Im**) import; (**na**) not applicable; (**p**) regulation planned; (+) regulation present; (-) regulation absent.

¹ While this table provides an overview of the extent of regulation in the sector, it is not a comprehensive summary of all permits and certification pertaining to all segments of aquaculture in the region. No data available for Jordan. Certification of imports may be achieved by receipt of certification provided by the exporting country.

² In Oman regulations are in place since 2004 although there is not yet production of eggs, juveniles or broodstock for export.

³ Tunisia: for quality of market size fish, the same certification procedures are used as in the European Union.

⁴ United Arab Emirates: regulation of fish eggs applies only to import and re-export of caviar (sturgeon eggs) for human consumption; regulation of import of juveniles and broodstock relates to being free of diseases.

Regulation (via certification and/or permits) of fish feed export and import is conscientiously practiced in the region. Export is regulated by three of four countries, namely Egypt, Iran (Islamic Republic of) and Saudi Arabia; there is presently no certification or permit process for export of feeds from the United Arab Emirates. Import is regulated by nearly all (12) of the 14 countries that import some or all of their feeds: Algeria, Bahrain, Egypt, Lebanon, Libyan Arab Jamahiriya, Iran (Islamic Republic of), Morocco, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Tunisia, United Arab Emirates; there is presently no certification or permit process in place for import of feeds into Iraq or Yemen.

3.4 Cost of production of aquatic species

Information on the cost of production of aquatic species is available from five regional producers: Egypt, tilapia US\$0.78/kg, mullet US\$1/kg, and carp US\$0.70/kg (intensive culture); Iran (Islamic Republic of), Chinese carp US\$0.62, rainbow trout US\$1.68, and shrimp US\$3.25/kg; Morocco, European seabass US\$4/kg, and gilthead seabream US\$4/kg; Oman, European seabream US\$1.50/kg; and Saudi Arabia, tilapia US\$1.95/kg, shrimp US\$4/kg, and marine finfish (average) US\$1.73/kg.

3.5 Market prices

Limited data is available on price differential for wild versus cultured fish of the same species (Table 3.6). In some countries such as Egypt and Iran (Islamic Republic of) there are no price differentials, while other countries report marked differences, for example in Libyan Arab Jamahiriya, the European seabass sell for US\$9–17/kg if wild caught, and only US\$5–6 if cultured, similarly the gilthead seabream sell for US\$7–12/kg if wild caught, and only US\$4.5–5.0 if farmed. Similarly in Morocco and the Syrian Arab Republic, wild caught fish command a higher price than farmed fish. In Oman, the opposite differential is seen, with gilthead seabream (an introduced species) selling for US\$4.50/kg if cultured and only US\$1.30/kg for a similar endemic wild species; similarly yellowfin seabream sell for US\$2.57/kg if cultured, which is more expensive than wild fish of the same species.

Table 3.6 Price differentials in wild and cultured finfish. *Data sources:* NASOs and PAFADs.

Country	Price differential wild vs. cultured	Species 1 wild vs. cultured (Prices in US\$/kg)	Species 2 wild vs. cultured (Prices in US\$/kg)
Egypt	no	–	–
Iran (Islamic Republic of)	no	–	–
Libyan Arab Jamahiriya	wild > cultured	European seabass wild 9–17 cultured 5–6	Gilthead seabream wild 7–12 cultured 4.5–5.0
Morocco	wild > cultured	European seabass wild 7–10 cultured 6	Gilthead seabream wild 7–9 cultured 6
Oman	wild < cultured	Gilthead seabream wild ¹ 1.3 cultured 4.5	Yellowfin seabream wild ¹ < cultured cultured 2.57
Syrian Arab Republic	wild > cultured	Common carp wild 1.7–2.1 cultured 1.3–1.5	Tilapia - Price not related to wild or cultured, but size. Larg wild fish fetch higher prices than small farmed fish

¹ Local wild caught endemic equivalent.

4. CONTRIBUTION TO FOOD SECURITY, ACCESS TO FOOD AND NUTRITION

Data sources: The information in this chapter has been extracted from the NASOs and PAFADs submitted by the countries in the region unless specified.

4.1 Regional food security

Consumption of fish (all source) across the Near East and North Africa varies greatly, both in absolute and relative terms (Table 4.1). In absolute terms, fish consumption per person per year is high (>20 kg) in the United Arab Emirates, Oman and Yemen (33, 26 and 30 kg, respectively), moderate (10–20 kg) in Bahrain, Egypt and Qatar, and low (<10 kg) in Algeria, Iran (Islamic Republic of), Kuwait, Lebanon, Libyan Arab Jamahiriya, Morocco, Tunisia, Saudi Arabia and Syrian Arab Republic.

Within the region as a whole, aquaculture contributes 18.7 percent to total fisheries production (2003 data). The contribution of aquaculture to total fisheries production varies sharply from country to country within the region: by this parameter the countries cluster into three groups: (i) those in which reported production from aquaculture contributes approximately 50 percent of total fisheries production (57 percent in Jordan, 50 percent in Egypt, 44 percent in the Syrian Arab Republic); (ii) those in which aquaculture contributes approximately 20 percent (21 percent in the Islamic Republic of Iran, 18 percent in Saudi Arabia, 16 percent in Lebanon), and (iii) those in which aquaculture contributes less than 10 percent (all remaining countries) (see Table 2.2).

The decade 1994 to 2003 witnessed dramatic increases in percentage contribution of aquaculture to the total fisheries production of individual countries (Table 2.2). For 10 of 17 countries, aquaculture contributed a smaller percentage of total fisheries production in 1994 than in 2003, and for a number of countries – representing both large and small producers – this change was dramatic; for example Egypt = 15.4 percent versus 50.8 percent; Islamic Republic of Iran = 7.8 percent versus 20.8 percent; Jordan = 17.3 percent versus 57.5 percent; Lebanon = 8.2 percent versus 16.9 percent; and for Saudi Arabia = 3.9 percent versus 18.3 percent. For Libyan Arab Jamahiriya, while the percentage contribution was small in both 1994 and 2003 (0.1 percent versus 1.1 percent), there was nonetheless a large relative increase. For several of the emerging producer countries, aquaculture did not contribute to fisheries production in 1994, but did contribute in 2003.

4.2 Relative contribution of fish compared to other sources of protein

In relative terms, consumption of fish is lower than that of red meat and poultry across the region. Egypt is the only country in which consumption of fish exceeds that of red meat (bovine, mutton, and goat) and poultry. The relative contribution of fish to the total animal protein varies greatly from country to country, fish contributes between 15–25 percent of total protein in Egypt, Morocco, Oman and Yemen, between 5–15 percent in Algeria, Bahrain, Iran (Islamic Republic of), Iraq, Kuwait, Jordan, Lebanon, Libyan Arab Jamahiriya, Qatar, Saudi Arabia, Tunisia and the United Arab Emirates, and <5 percent in the Syrian Arab Republic (Table 4.2).

Depending upon the parameters used to evaluate the relative dietary contribution of fish compared to other sources of protein, (fish vs. animal protein; fish vs. total protein; consumption or production), fish plays a 5–41 percent contribution (see Table 4.1). Disparate data reporting precludes detection of regional patterns and trends.

4.3 Fish consumption trends: geographic and temporal

Within some countries in the Near East and North Africa, there are marked local differences in fish consumption that are linked to proximity to the coast. Coastal communities have a heritage that is linked to the sea, and thus fish is an integral part of the local diet. In inland communities this is not the case, and fish consumption is typically low. The within-country differences are most marked in large countries such as Algeria, Egypt, Iran (Islamic Republic of), Libyan Arab Jamahiriya and Saudi Arabia. For example, in coastal regions of Egypt, fish consumption is nearly twice as high as in the cities, and in coastal cities of Tunisia, mean fish consumption is 20 kg/person/year, whereas in inland

areas, mean fish consumption is only 2 kg/person/year (Table 4.1). In coastal regions of Iran (Islamic Republic of), fish consumption exceeds that of meat, whereas in inland regions, the opposite pertains.

Table 4.1 The importance of fish and fish products in the regional diets. *Data sources:* NASOs and PAFADs.

Country	Fish consumption (kg/person/yr)	Fish contribution to food consumption and/or production Fish vs. meat (poultry, red meat) as protein source (%)	Fish consumption trends	Consumption of fish vs. meat Geographic/local difference
Algeria	5.1 (2003)	f/f+po+rm = 0.01% p	Increasing 3.0 kg/per/yr (1993) 5.1 kg/per/yr (2003)	Rural: f<po+m Urban: f<po+m
Bahrain	16.7 (2003)	fish/animal protein = 11.8% c fish/total protein = 5.2% c	Stable 16 kg/per/yr 1990–2003	No differences
Egypt	15 (2003)	fish/total protein = 27.6% c	Increasing 5.5 kg/per/yr (1982) 14.9 kg/per/yr (2003)	Rural: f>po+rm Urban: f<po+rm Coastal fish consumption = 1.8 times city
Iran (Islamic Republic of)	6.1 (2004)	fish/animal protein = 11% c	Increasing <1kg 1980 6.1 kg 2004	Coastal: f>po+rm Inland: po+rm>f
Kuwait	5.5 (2003)	nd	nd	nd
Lebanon	4	nd	nd	Coastal + city marine fish, Bekaa rm+po, Rainbow trout
Libyan Arab Jamahiriya	6.5 (1997)	fish/total protein = 14% c	Increasing in eastern and rural areas	Urban fish consumption more than rural
Morocco	7.5	f/f+po+rm = 0.2% p	nd	nd
Oman	25.8 (2001)	f/f+po+rm = 85% p	Increasing	No differences
Qatar	12	f/f+po+rm = 41%	nd	No regional differences because country is small
Saudi Arabia	7.9 (2002)	f<po+rm	Increasing	nd
Syrian Arab Republic	1.77 (2003)	f/f+po+rm = 4.2% c fish/animal protein = 2.8% p	Increasing 0.5 kg/per/yr (1985) 0.8 kg/per/yr (1995) 1.3 kg/per/yr (2000) 1.8 kg/per/yr (2004)	Rural: po>rm>f Urban: rm>po>f
Tunisia	9.5	f/f+po+rm = 40% c f/po+rm = 30% p	Increasing	Coastal cities: 20 kg/per/yr Inland: 2 kg/per/yr
UAE	33	fish very important in diet	nd	Consumption of fish high in coastal regions than inland
Yemen	30	see last column on right	Increasing in inland areas	Coastal: f>po+rm Inland: f<po+rm

Abbreviations: (c) consumption; (f) fish; (p) production; (po) poultry; (rm) red meat; (nd) no data.

Table 4.2 Consumption of fish and other animal protein in 2001. Per capita supply in kg. *Data source: FAO FISHSTAT Plus.*

Country	Fish	Bovine	Mutton + goat	Pig	Poultry	Meat other	Meat total	Fish/animal protein (%)	Fish/total protein (%)	Fish/capita supply April 1991–2001
Algeria	4.6	3.6	5.8	0.0	7.5	0.4	17.3	7.8	1.9	4.0
Bahrain	13.5	nd	nd	nd	nd	nd	Nd	9.7	4.2	-1.6
Egypt	14.9	9.3	1.6	0.0	9.2	2.1	22.2	24.5	4.6	6.2
Iran (Islamic Republic of)	4.8	4.9	6.6	0.0	13.3	0.2	25.0	6.7	1.6	3.3
Iraq	1.5	nd	nd	nd	nd	nd	nd	6.2	0.8	5.2
Kuwait	7.7	4.5	16.9		45.5	0.2	67.0	5.3	2.6	6.8
Jordan	4.2	5.3	3.4	0.0	23.0	0.1	31.8	5.2	1.6	2.8
Lebanon	10.5	12.8	4.7	2.9	26.0	0.0	46.5	8.6	3.3	11.6
Libyan Arab Jamahiriya	7.1	3.8	6.5	0.0	18.6	1.0	29.9	7.9	2.4	-1.5
Morocco	9.0	5.4	4.9	0.0	8.7	1.3	20.3	17.6	3.4	2.1
Oman	26.0	nd	nd	nd	nd	nd	nd	21.6	11.6	1.4
Qatar	19.5	nd	nd	nd	nd	nd	nd	10.9	4.6	-0.8
Saudi Arabia	7.2	2.5	6.2	–	35.5	1.8	46.1	6.6	2.6	2.0
Syrian Arab Republic	2.2	2.5	10.2	0.0	7.0	0.2	20.0	3.3	0.9	13.9
Tunisia	11.1	6.5	6.8	–	12.2	0.9	26.4	12.8	3.5	2.5
UAE	26.3	5.4	11.9	–	55.2	4.9	77.4	13.3	6.4	2.5
Yemen	6.9	3.2	2.6	0.0	7.5	0.2	13.6	19.6	3.9	0.4

Abbreviation: (nd) no data.

The limited data available on comparative consumption of fish versus terrestrial meat in rural and urban societies shows that local differences exist in some countries. For example, in Egyptian rural societies, consumption of fish exceeds that of poultry and red meat, whereas in urban societies the reverse is the case. This contrast is mainly attributable to both costs of the different types of protein, and to the income levels in the different regions. Fish is generally more affordable for the rural population than is terrestrial meat, since the former is less expensive – a key factor affecting the poorer rural consumer. In contrast to the local rural/urban differences in Egypt, in Libyan Arab Jamahiriya rural societies there is more poultry and meat consumed than fish, and in urban areas more fish is consumed; in contrast are no clear differences in consumption between rural and urban societies in Bahrain and Oman.

Fish consumption (measured by kg/person/year) is increasing in ten of the eleven countries for which temporal trends in consumption are reported (Table 4.1). Consumption is increasing in Algeria, Egypt, Iran (Islamic Republic of), Libyan Arab Jamahiriya, Oman, Saudi Arabia, Syrian Arab Republic, Tunisia, United Arab Emirates and Yemen, and remains stable in Bahrain. In Algeria, consumption has increased from 3 kg/person/year in 1993 to 5.1 kg/person/year in 2003. In Egypt, consumption has increased from 5.5 kg/person/year in 1982 to 14.9 kg/person/year in 2003. In the Islamic Republic of Iran consumption has increased from <1 kg/person/year in 1980, to 6.1 kg/person/year in 2004, and is expected to reach 10 kg/person/year in 2009.

Among the factors supporting increased absolute consumption are increased public awareness of the health benefits of eating fish (Islamic Republic of Iran, Libyan Arab Jamahiriya and Yemen), increased tourism (Tunisia), establishment of inland aquaculture facilities (Islamic Republic of Iran), improved facilities for refrigerated long distance transportation (Libyan Arab Jamahiriya and Yemen), and improved handling (Yemen). Improved transportation of the aquaculture products is a driving force in the increased fish consumption in rural areas of such countries as Libyan Arab Jamahiriya and Yemen. The expansion in aquaculture activities, at a rate exceeding that of the population growth, resulted in an increase in fish consumption in the Syrian Arab Republic (1980–1998). This increase became more obvious following the lifting of fish import banning for canned fish (1999) and frozen/fresh fish (2004).

5. ENVIRONMENT AND RESOURCES

Data sources: The information in this chapter has been extracted from the NASOs and PAFADs submitted by the countries in the region unless specified.

5.1 Losses due to infectious diseases and other causes

The diseases status is known for approximately half of the countries in the Near East and North Africa and it is clear that diseases have impacted aquaculture of both finfish and crustaceans. In general the losses have been limited, although Kuwait experienced major losses in marine cages in 1999 and 2001. In the major producer country, Egypt, losses due to disease are estimated to be <0.8 percent of production; in the smaller producer country, the Syrian Arab Republic, losses due to infectious diseases are estimated at around 4–5 percent, and a maximum loss of 10 percent of planned production (as may occur in the case of tilapia during sudden temperature drops). The disease status is not known for approximately half of the countries in the Near East and North Africa region, including several of the emerging producer countries where commercial aquaculture is still in its infancy.

Among finfish in the region, infectious diseases are the most common, and etiological agents include bacteria (*Aeromonas*, *Flexibacter*, *Streptococcus*), fungi (*Branchiomyces*, *Oodinium*, *Saprolegnia*), and protozoan and metazoan parasites, particularly ectoparasites such as the ciliate *Ichthyophthirius*, and the crustaceans *Argulus* and *Lernaea*. Environmental degradation has also contributed to losses, when mass mortality of caged finfish in Kuwait Bay resulted from algal blooms in 1999–2001. Poor feed quality and stress have also adversely affected fish production in Lebanon and the Syrian Arab Republic. Among crustaceans, Marteliasis was notified for *Ostrea edulis* in a lagoon in Morocco, and

white spot disease has necessitated closure of production at a shrimp farm complex in Iran (Islamic Republic of) for the last three years.

5.2 Feed resources

Some 462 600 tonnes of fish feed per year are commercially produced in the region. Domestic production takes place in five countries: Egypt, Iran (Islamic Republic of), Saudi Arabia, Syrian Arab Republic and the United Arab Emirates (a small amount in the latter). The major regional producers are Egypt, which produced 420 000 tonnes in 2003, and Iran (Islamic Republic of) produced 34 000 tonnes in the same year. Domestic production of fish feed is a key element supporting rapid growth of aquaculture, and rapid expansion of this is particularly important in Egypt.

Some 14 000 tonnes of fish feed are imported by the countries in the region each year. Imported feed is obtained from both within the region (exporters are Saudi Arabia and United Arab Emirates), and beyond the region, from as far away as Europe (Austria, Denmark, Italy, Netherlands, Portugal), North and South America, and South East Asia, including Japan.

Two countries in the region are self sufficient in feeds, namely Egypt (the largest regional producer), and the Syrian Arab Republic (a small producer). Two further countries are nearly self-sufficient in feeds, supplementing significant domestic production with imports, namely Iran (Islamic Republic of) (the second largest producer in the region) and Saudi Arabia (the third largest regional producer). The remaining countries are completely reliant upon imported feeds to meet their demand. Table 5.1 summarizes the information available on fish feed and fishmeal production and imports in the region.

In Egypt and Saudi Arabia, the two largest regional producers, commercial production of feed is regulated. Although little regional data is available concerning quality issues affecting commercially available feeds, in Iran (Islamic Republic of), the quality of domestically produced feed is unstable, due to unstable raw materials. In the Syrian Arab Republic, fish pellets are poor in animal protein, and lack microelements, some essential amino acids, essential fatty acids, and high quality animal protein. Such problems have prompted illegal use of fresh by-products from slaughter houses.

5.3 Trash fish, raw fish and fishmeal

From the limited data available on use of trash fish and raw fish, it appears that these resources are relatively little used in aquaculture in the Near East and North Africa. In the major producer country, Egypt, there is limited use of raw fish (sardines, silversides, small shrimp and tilapia) for seabass and meager farming, where the raw fish are used to enhance the final flavour of the cultured stock. In Libyan Arab Jamahiriya, sardines are used in the bluefin tuna farming. In Saudi Arabia, trash fish or raw fish is used as additional feed supplements for broodstock of some cultured marine species; for example fresh mackerel is fed to seabass, and fresh squid are fed to shrimp. In the United Arab Emirates, trash fish (Caraganidae, Lethrinidae, Pomodidae, Sparidae, and tuna) from the Dubai fish market is collected and used to produce fishmeal.

The annual amount of fishmeal produced within the region is estimated to be some 86 700 tonnes. Among the 15 countries in the region for which data is available, 7 are known to produce fishmeal, the highest production being in Morocco and Iran (Islamic Republic of), which in 2003, produced around 75 000 tonnes and 10 300 tonnes, respectively. The amount of fishmeal imported into the region is estimated to be 141 000 tonnes per year (Table 5.1). Among the 15 countries in the region for which data is available, 7 import fishmeal, the largest importers were Iran (Islamic Republic of) and Egypt (about 67 000 and 65 000 tonnes, respectively).

The limited data available on the amounts of fishmeal used in the aquaculture and terrestrial animal sectors of food production shows that there is great variation across the region. In Oman and Tunisia most fishmeal is used for livestock feed, in Libyan Arab Jamahiriya and the Syrian Arab Republic most is used in poultry production. In Saudi Arabia, fishmeal is the principal imported item needed

for local formulation of fish feeds. Furthermore, Saudi Arabia exports annually to the United Arab Emirates about 500 tonnes of fish feed and an additional 200 tonnes to other GCC countries.

Table 5.1. Fish feed and fishmeal production and import in the Near East and North Africa region. *Data sources: NASOs and PAFADs.*

Country	Fish feed production (tonnes/year)	Fish feed import (tonnes/year)	Fish feed import sources	Fishmeal production (tonnes)	Fishmeal import (tonnes)
Algeria	0	0	–	0	0
Bahrain	0	33	Saudi Arabia, UAE	0	0
Egypt	420 000 (2003) fast expansion	0	–	limited	65 000
Iran (Islamic Rep.)	34 000 (2003) 10 companies 19 capacity	+	Denmark, South East Asia	10 304 (2003)	66 932 (2003)
Kuwait	0	80 439	Netherlands, USA	0	0
Lebanon	0 ¹	2 467 (2004) 1 978 (2003) 2 185 (2002) 2 604 (2001) 2 899 (2000)	Chile, South America, Denmark, Italy	0	2 467 (2004)
Libyan Arab Jama.	0	264 (2005)	Austria, Italy, Netherlands, Portugal	391 (1998)	0
Morocco	0 or negligible	2 500	Spain	75 000 (2003)	0
Oman	0	1 900 Total 2001-2004 Average: 475/yr	France (only once), Saudi Arabia	273 (2004)	56 (2003)
Qatar	0	38 (2005)		0	0
Saudi Arabia	20 000 (2003) several firms	3 000 (2003) mainly shrimp feed	Thailand	0	6 000 (2003)
Syrian Arab Rep.	5 600	0	–	0	566
Tunisia	0	3 500	Europe (mainly France, Italy, Spain)	nd	negligible
UAE	8	5 (government) 1 500 (private)	Europe	5	2
Yemen	0	pellets algae culture <i>Artemia</i>	Japan Egypt + UAE Greece + Japan	281 (2002) 159 (2003) 771 (2004)	0
TOTAL	479 608	14 038	–	86 744	141 023

Abbreviations and symbols: (nd) no data; (+) amount not reported.

¹ Feed mill under construction

5.4 Seed resources

Some countries within the region produce only the seed they need, other countries produce in excess of their own needs and therefore can export seed, while other countries are completely reliant upon imports. The principal exporter countries for seed, fry and fingerlings are Bahrain, Egypt and Kuwait, and most of their products are imported by other countries within the region. However, as a whole, the Near East and North Africa region is not yet self sufficient in seed, fry and fingerlings, and is reliant

upon imports from other parts of the world, namely trout and carp from Europe and the USA, and several species of coastal fishes are imported from Europe (for more details, see section 3.2 Export and Import).

5.5 Fragile environments

In considering environments and resources pertaining to aquaculture in the marine environments of the Near East and North Africa, two fragile ecosystems are important to consider, namely mangroves and coral reefs.

Mangroves forests are present in approximately half of the countries in the Near East and North Africa, namely Bahrain, Egypt, Iran (Islamic Republic of), Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates and Yemen. These fragile marine ecosystems are intrinsically of great importance, and play a vital role in the health of coastal zones in many ways: trapping, cycling and provision of nutrients; provision of attachment surfaces for marine organisms; provision of protected nursery and spawning areas for fish, crustaceans and shellfish; and provision of shelter in their roots and branches. Healthy mangroves forests also benefit the human population, by supporting sustainable recreational and semi-commercial fisheries, by protecting against wave and flood damage (by enabling overflowing water to be absorbed into the expanse of the forest), and helping to prevent erosion, and stabilizing shorelines with their specialized root systems.

All the regional countries with mangrove forests either have established, or are establishing, actions and policies to safeguard these coastal zones. Although clearance of mangrove for dredging and reclamation for tourism and urbanization has taken place in Bahrain, the Directorate of Marine Resources (DMR) has proposed a development plan for bio-fencing the cleared areas with mangroves to restore the mangrove vegetation in the cleared areas. Restoration and rehabilitation of mangrove forests is being practiced in Saudi Arabia, and establishment of new mangrove forests are either planned or underway in Kuwait, Qatar and the United Arab Emirates. Across the region, aquaculture is generally prohibited in mangrove forests, and aquaculture can only be practiced in the vicinity of the forests with certain restrictions, for example in Iran (Islamic Republic of), no aquaculture farms can be established within 10–15 km of a mangrove forest.

Coral reefs are also present in approximately half of the countries in North Africa and the Near East. All the countries with coral reefs either have established, or are establishing, actions and policies to safeguard them, and aquaculture is generally prohibited in the vicinity of such reefs.

On a related theme, it is of interest to mention an example in which aquaculture is actively used in environmental rehabilitation. In the Syrian Arab Republic, aquaculture not only plays a significant role in binding farmers to their lands and original livelihoods, thus minimizing migration from rural to urban areas, but is also playing an important role in environmental protection and conservation. After the erection of the Euphrates dam and formation of the Assad Lake, salinization of the lands in the Euphrates basin became destructive to the agricultural economy. Since the mid-1990s, the Fisheries Department within the Ministry of Agriculture, has been conducting field experiments to investigate the feasibility of pond fish culture on these salinized lands. Field trials were promising, and showed that non-arable salinized land can be used for pond fish farming; aquaculture on such salinized lands decreased the salt content in the upper layer of the soil, rehabilitating it for agriculture for one or two years; and aquaculture or fish culture-crop culture rotation can be a wise approach to revitalize salinized lands and make use of them. Three pilot farms and 40 fish farms were established in the Euphrates valley.

6. LEGAL, INSTITUTIONAL AND MANAGEMENT ASPECTS

Data sources: The information in this chapter has been extracted from the NASOs and PAFADs submitted by the countries in the region unless specified.

6.1 Strategy

The countries of the Near East and North Africa exhibit a broad diversity of strategies for aquaculture, ranging from the government designation of aquaculture development as a high priority (often with a strong supporting legal, institution, economic infrastructure), to an absence of economic development plans and no published policy.

Among the reasons for government strategies that support aquaculture are: to diversity the economy, to generate wealth, to generate foreign currency earnings via export, increase employment, increase the domestic food supply, to generate jobs in poor areas, and to bring about social and economic improvement in communities with limited economic alternatives (see also section 7.3 Aquaculture and poverty reduction, and section 8.3 Driving forces).

Recognizing that the economic and social benefits of aquaculture growth are not without their negative consequences, some countries have aquaculture development strategies that promote sustainable development and good stewardship of the environment (policies that may generally be referred to as “eco-friendly”). Examples of countries with such approaches and policies are Bahrain, Iran (Islamic Republic of), and the Syrian Arab Republic.

The countries in the Near East and North Africa region can be grouped according to the priority afforded to their aquaculture development:

Low priority	Bahrain and Morocco
Medium priority	Algeria, Qatar, Yemen and United Arab Emirates
High priority	Egypt, Islamic Republic of Iran, Kuwait, Libyan Arab Jamahiriya, Oman, Saudi Arabia, Syrian Arab Republic and Tunisia

Note: The priority status of aquaculture is not known for Iraq and Jordan.

6.2 Legal and institutional framework

Regulation of aquaculture within the countries of the Near East and North Africa is typically complex, reflecting that the sector has many very diverse facets, ranging from land use to quality control of the final product. Regulation of such diversity may be managed by numerous different government agencies within a country, usually lead by an agency such as the Ministry of Fisheries or Ministry of Agriculture (in some countries there is a joint Ministry of Agriculture and Fisheries), or the Directorate of Marine Resources. For example, in Morocco, there are two government bodies primarily in charge of aquaculture, with an additional 13 government agencies also involved. However, for some countries all rules and regulations pertaining to aquaculture are covered in a single framework (as has been the case in Bahrain since 2002).

Laws and regulations for aquaculture include, but are not limited to, those concerning: licensing and siting of farms (license applications may require an environmental impact assessment; some small-scale and traditional farms may be exempt from licensing), water use (for example, in Egypt, only agricultural drainage or lake water may be used to supply a land fish farm; it is strictly forbidden to use irrigation water), effluent discharge, designation of protected areas, allocation of public land for farms, identification of suitable species, feed allocation, quality assurance of aquatic feeds, control of import of live fish for aquaculture [which may include certification that they are free of diseases listed by the World Organisation for Animal Health (OIE)], regulation of introduction of exotic species and transfer of local species, use of aquatic genetically modified organisms, health certification of

exported live aquaculture products, packing and transportation of fish, monitoring and inspection of farms, prevention of disease, collection and publication of production statistics.

Other institutional responsibilities may include: market analysis of aquaculture products, issuing statistical data, planning and preparation of national development plans for aquaculture, provision of support services (such as training, extension, and research), development and adaptation of technologies, restocking, development of legislation, and representing the sector in regional and international organizations.

It is important to note that within the region, there is a great heterogeneity in the legal and institutional framework for aquaculture, and not all of the aspects listed above are currently part of the laws and regulations in all countries. All countries do have legislation and regulation pertaining to the basic establishment and operation of aquaculture facilities, including the need to obtain permission from the authorized government body before a company can begin an aquaculture project. However, fewer countries have legislation and regulation pertaining to such aspects as use of chemicals and drugs in aquaculture (including lists of approved drugs), and prevention and control of disease outbreaks including preparation and implementation of emergency and contingency plans (see also section 8.4, iii Priority issues: health and diseases). Some of the emerging producer countries, such as Oman, already have a policy, legal and administrative framework in place for their new aquaculture industry.

For some of the countries in the Near East and North Africa, compliance with European Union regulations is key to the success of their aquaculture industry. Such compliance is of particular importance for quality and safety standards of fish and shellfish especially that destined for export to consumers in the EU. Adherence to EU standards pertains in Egypt, Morocco, Iran (Islamic Republic of), Saudi Arabia, and Tunisia (see also section 3.3 Labelling, permits and certification).

Laws and regulations may be updated in cooperation with adjacent countries. For example, recommendations on common regulations that could be adopted at the regional level will be likely proposed for all countries members in RECOFI (the Regional Commission for Fisheries, within the framework of FAO), namely Bahrain, Iran (Islamic Republic of), Iraq, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates.

A critical shortage of technical experts in some countries compromises their capacity and ability in such areas as development planning and policy, quality control and enforcement of existing regulations such is the case in Saudi Arabia (see section 8.4, iv. Priority issues: Policies, legal framework, institutions and investment).

6.3 Economic instruments

Governments may provide many forms of economic support for aquaculture, ranging from financing aquaculture research and development facilities, to offering a wide range of economic incentives for investors. The diversity and size of the different economic instruments varies greatly among the countries in the region, and is dependant upon such factors as the economic condition of the country, the stage of development of the sector, local investment climate and attitudes, and the extent of the priority given to the aquaculture sector by the individual governments.

Governments typically support research and development programmes, with are conducted at national aquaculture development facilities. Such support is critical in the early phases of the industries growth, and focuses on such aspects as selection of suitable species and technologies. However, for some countries, the facilities, expertise, and funding of research and development are inadequate (see section 8.4, iv Priority issues: Policies, legal framework, institutions and investment).

Beyond support of research and development, some countries also engage in a variety of other financial measures to support their aquaculture industry, incentives include: long lease of public land, use of coastal lands at nominal fees, low priced suitable land, subsidies on feed ingredients, free

distribution of seed, soft loans (possibly with a grace period) to encourage majority local ownership, waived or decreased duty on imported equipment, decreased port fees, and some days of free port storage of exported goods. To encourage foreign investment, incentives include: permits to bring in technical staff from other countries, allowing foreign investment (even if not full foreign ownership), guaranteed safety of investment, full repatriation of profits, and some years with no taxation (this may be up to 20 years). While some countries such as Bahrain and Morocco do not presently offer any financial incentives for private sector investment in aquaculture, other countries offer many of the financial incentives listed above.

Since aquaculture is a new activity for some countries, unfamiliar to investors and to the financial sector, and possibly perceived as high risk, information dissemination is key. For example, in the Syrian Arab Republic, the Department of Fishery Resources in the Ministry of Agriculture and Agrarian Reform, disseminates information about existing investment opportunities to the chambers of agriculture, commerce and industry.

Both national and international investors may be sought, and some countries, such as Egypt and Saudi Arabia, encourage foreign investment. Preliminary assessment of the potential for investment in aquaculture may be made with assistance from sources such as FAO.

In Oman, there is a dynamic private sector wishing to invest, and in Saudi Arabia, local investment is supporting the boom in shrimp farming. In Yemen, funding for the largest aquaculture farm in the Middle East has come from German investment.

6.4 Professional associations, training and education infrastructure

Producer associations

Professional organizations, such as societies of fish farmers, provide important networks for support, exchange of information within the sector, and decision making. Typically the presence and extent of such organizations parallels the state of development (both production tonnage and duration of establishment, see Table 9.1) of the sector in any individual country. For example, in Egypt, there are seven aquaculture cooperatives, with a membership of some 1 350 individuals, and formed under the umbrella of the General Aquatic Resources Cooperatives Union, a Non-governmental Organization (NGO). In Iran (Islamic Republic of), there are three cooperative unions, one each for coldwater, warm water, and shrimp production; the unions have been formed to lead aquaculture development, to collaborate in decision making and to support farmers. In Lebanon, the fish farmers in Bekka are organized geographically. In Saudi Arabia there are currently no producer associations despite ranking third among the producers in the region and having a two decade engagement in the industry. The Government, however, plans to facilitate development of such associations in cooperation with the Chamber of Commerce.

Training and education infrastructure

A strong training infrastructure is also crucial for effective support of the aquaculture industry, and is of particular importance for countries with a developing industry in which a critical mass of expertise is lacking.

University courses in aquaculture, at the undergraduate and/or graduate levels, are currently offered by universities in Egypt, Iran (Islamic Republic of), Kuwait, Libyan Arab Jamahiriya, Oman, Saudi Arabia, Syrian Arab Republic and Tunisia. Courses are offered in general topics as aquatic science, fisheries science, hydrobiology, marine biology, and oceanography, and specific topics such as aquaculture, aquaculture hygiene, disease, feeding, fish husbandry, food hygiene, genetics, and production. In the two largest regional producer countries, Egypt and Iran (Islamic Republic of), aquaculture related courses are taught at 10 and 20 universities respectively, and both countries offer aquaculture related education at undergraduate and postgraduate levels. In small producer countries,

more limited aquaculture related training is available, for example Kuwait offers undergraduate level education in fisheries science, and then encourages its graduates to pursue higher studies in reputed foreign institutions.

Universities may also conduct research in aquaculture, as is the case in Egypt, the Islamic Republic of Iran, Oman and Saudi Arabia, and this capacity can be used to support the industry. Government supported aquaculture training centres can be used as a conduit for conveying the results to the aquaculture industry. However, in some countries – such as Lebanon, Iran (Islamic Republic of) and Saudi Arabia – cooperative links are weak between the different sectors responsible for research, such as some sectors of the government, universities, and industry. Thus, some research capacity is under utilized, and results may not be promptly translated into application. In Lebanon and Yemen, some infrastructure to support aquaculture has been compromised due to damage in years of social unrest and internal conflicts.

Further support can come from government research institutions and from technical cooperation agreements between government department and private companies, as is happening in one instance in Bahrain.

Fisheries research centres and extension

Larger producer countries, such as Egypt, Iran (Islamic Republic of), and Saudi Arabia, provide comprehensive government-supported research, extension and support services, such as pilot farms, hatcheries, and laboratories, and these services may be offered free or for a nominal fee. A key role of such centres is the provision of field and basic training in all aspects of aquaculture operation, and extension services such a regular meetings, and dissemination of information. Such services provide an additional source of training for improving the skills of the staff in the aquaculture industry in addition to formal university training. The government training schemes are often targeted at less educated segments of the workers at the farms than are the university courses. Some smaller producer countries may also undertake research, and offer training and expertise advice through government supported facilities, as is the case in the Ministry of Agriculture and Fisheries, in Oman, and at the Marine Biology Research Centre in Libyan Arab Jamahiriya, respectively.

Training programmes may be offered in association with such international sources of expertise as FAO.

Research planning

In countries with a large aquaculture sector, a number of different stake holders may be involved in deciding research priorities. In Egypt, there is usually direct contact between the research institutions, the producers, GAFRD (General Authority for Fish Resources Development), and the Egyptian Aquaculture Society. Depending upon the level or research results may be published in scientific journals, and or in magazines of local aquaculture societies. In Iran, (Islamic Republic of), fisheries research projects are submitted for consideration by the Supreme Committee or Research, which is comprised of university professors, representatives of the executive department of the Iranian Fisheries Organization, and some experienced researchers and experts.

7. SOCIAL IMPACTS, EMPLOYMENT AND POVERTY REDUCTION

Data sources: The information in this chapter has been extracted from the NASOs and PAFADs submitted by the countries in the region unless otherwise specified.

7.1 Contribution of aquaculture to employment

Across the region at least 86 700 individuals are employed in the aquaculture sector (the actual numbers will be slightly higher if one also considers employment in Iraq and Jordan). The greatest

number of employees, approximately 60 000, work in Egypt (the regions leading producer), followed by Iran (Islamic Republic of) with approximately 17 000 employees. In some countries with low production, there may be less than one hundred individuals employed in aquaculture (Table 7.1).

In assessing the economic benefits from employment in aquaculture, it is helpful to consider the ratio of economic support, meaning the number of individuals that can be supported by one employee. Although limited data is available for this parameter, both Morocco and the Syrian Arab Republic report a ratio of approximately 1:5. If this ratio of economic support were applied across the region, one can estimate that with 86 400 full time employees, some 423 500 individuals are supported.

Aquaculture offers a diversity of employment opportunities, whether full-time, part-time, or seasonal. Employees may work directly in the aquaculture facilities; in support activities such as feed mills, processing units, and distribution; and in ancillary activities such as pond and building construction, and manufacturing of aquaculture equipment and tools.

Table 7.1 Employment, gender distribution and education level in the aquaculture sector.
Data sources: NASOs and PAFADs.

Country	Employees (total)	Education	Women	Comments
Algeria	400	5% management 10% engineers 85% labourers	None	3 028 projected for 2007
Bahrain	32 Government 21 Private 11	Ph.D., M.Sc., B.Sc., School graduates Well trained	nd	Commercial farms yet to be started
Egypt	58 208–63 208	Limited education	Yes	60 000 used in total employee calculation
	Traditional family farms 35 000–40 000			
	Hatchery, cages, intensive 22 000	Technicians, skilled workers	Yes	
	Government 780 Support 428	Various Various	Yes Yes	
Iran (Islamic Republic of)	17 095		Very low	Employment critical in rural areas, 3 000 direct from shrimp, 3 000 indirect from shrimp, Plus part time for support activities
Kuwait	162	Technical staff	None	–
Lebanon	150 families	Intermediate	nd	–
Libyan Arab Jamahiriya	140	Experience & skills gained with time 10% management 20% engineers 70% labourers	Few, only in research centre	–

Country	Employees (total)	Education	Women	Comments
Morocco	454 permanent 112 temporary 41 other	20% scientists 20% technicians 60% labourers	Marginal	1:5 ratio of economic support
Oman	35 Ministry 9 Private 26	Ministry M.Sc., B.Sc., high school diploma	None	–
Qatar	10	Graduates in marine science	None	–
Saudi Arabia	3 407	Range from unskilled to highly educated staff	Generally restricted	Some women owners
Syrian Arab Republic	1 760 families supported by full time employment, 1 800 part time	Fisheries Dept.: Ph.D. B.Sc., high and technical school 32%, admin. 12%, labour 56%	Common	1:5 ratio of economic support
		Education/research: Ph.D., M.Sc., B.Sc., high school 75%, admin. 20%, labour 22%	Common	
		Government farms: M.Sc., B.Sc., high and tech. school 10%, admin. 20%, labour 70%	Marginal	
		Private farms: educated/skilled 30%, unskilled 70%	Not common	
Tunisia	>1 000	10% management 17% technical 73% labourers	None	–
UAE	46	Graduates and post graduates	None	–
Yemen	80 Research facility 30 Farm 50	Research facility 6 researchers 10 technicians 15 labourers	Marginal	–
TOTAL	84 771 (full time) 1 953 (part time) 86 724	–	–	–

Abbreviation: (nd) no data.

7.2 Profile of those working in the sector

The education level of employees ranges from unskilled labourers to highly trained professionals with graduate degrees, which may include a Doctorate. In general, unskilled labourers work in the least sophisticated areas of the industry, and more highly trained employees such as technicians and graduates work in the more technically advanced parts of the industry such as hatcheries, and government supported research and education facilities. Typically the newly developing aquaculture producer countries employ the highest percentage of highly trained personnel, because their industry is still in the technology and knowledge-intensive start-up phase. Three of the small producer countries, Algeria, Libyan Arab Jamahiriya and Tunisia, each estimate that the employees are distributed approximately as follows: 5–10 percent management, 10–20 percent technical, and 70–85 percent labourers (see Table 7.1).

Across the region, women form a very small part of the aquaculture work force. In the thirteen countries for which gender distribution is known, women in aquaculture are represented only in seven countries: Egypt, Iran (Islamic Republic of), Libyan Arab Jamahiriya, Morocco, Saudi Arabia, the Syrian Arab Republic and Yemen. Among five of these seven countries, participation is reported as very low, marginal or restricted; Egypt and the Syrian Arab Republic are the exceptions. In the Syrian Arab Republic, women are more commonly found as employees in the Government Fisheries Department and in education and research facilities, than in government or privately run fish farms (Table 7.1). In Saudi Arabia, even though women's participation in aquaculture as employees is low, some women are owners of aquaculture projects.

In Morocco, the Ministry of Fisheries has created a Gender Unit to try and improve the position of women in the fisheries sector. Efforts have been successful in the Oualidia Lagoon, where clams and oysters are cultured. However, in the Moulay Bouselham Lagoon, the efforts have not been successful due to resistance from larger-scale professional fisherman/fishery enterprises.

Across the region, children form a negligible part of the work force in aquaculture. A notable exception is in the Syrian Arab Republic, where farmer's children are involved, especially in the annual school vacation, the time of which coincides with peak aquaculture activity. This practice minimizes direct production costs and educates the children.

7.3 Aquaculture and poverty reduction

Aquaculture is recognized as providing important opportunities to poor families; for employment and income, and as a source of nutritionally healthy and affordable protein. In Algeria, the national five year plan for development of fishery and aquaculture has as a priority, the improvement of living conditions in disadvantaged rural areas, via income and job opportunities from aquaculture. In the Islamic Republic of Iran, a relatively established producer in the region, aquaculture is recognized as a very important source of food security in areas of the country with poor infrastructure. In the Syrian Arab Republic, aquaculture yields high income in comparison with other agricultural activities, and thus is economically advantageous in rural areas. The United Arab Emirates reports that employment in aquaculture can help address unemployment. In Egypt, employment in aquaculture does compensate for some of the jobs lost from traditional lagoon fishing.

Across the region, there are both geographic and temporal contrasts in participation in aquaculture by different wealth groups. Historically, most aquaculture has been traditionally been conducted at the local level, with small family farms. With increased sophistication of the industry, aquaculture employees may now include professionals with specialized undergraduate and graduate training. Furthermore, commercial investment (local and/or foreign) is becoming increasingly common. Thus, higher wealth groups are now involved in the industry in some countries.

7.4 Scale of operations, ownership and leasing

Within the region, there are sharp differences in the scale of aquaculture operations (Table 7.2). In some areas, retention and encouragement of smaller scale more traditional aquaculture practices are favoured. Reasons for this include limited water resources (natural or allocated), small scale property, limited financing (as in the Syrian Arab Republic), and also because of the social benefits that small farms confer, especially for employment in poor rural areas. Small scale operations are actively encouraged in Lebanon, Libyan Arab Jamahiriya, Morocco and the Syrian Arab Republic, for their socio-economic benefits. However, larger commercial operations have lower unit costs, may be managed more efficiently, and can offer the opportunities for vertical merger of many aspects of production, and such a situation is attractive in many areas. For example, in Iran (Islamic Republic of), the important and rapidly growing shrimp industry is moving towards industrial operation, with vertical merger (hatchery, farming processing and sale). In Egypt, the leading producer, there is a trend to smaller area, more efficient units (with greater production/unit area).

The extent to which farms are owned versus leases varies considerably between countries in the region. In most countries, farms are owned rather than leased. Across the region, most aquaculture facilities are privately owned, land-based, family farms. Commercial operations are more common for marine facilities, particularly shrimp farming. One particular development of note is that German investors will soon set up the largest fish farm in the Middle East, in Yemen.

Table 7.2 Scale of operation, ownership and leasing in the aquaculture sector. *Data sources: NASOs and PAFADs.*

Country	Scale of operation and trends Small → large?	Ownership	Ownership vs. leasing	Comments
Algeria	Extensive Semi-industrial	Mostly private and family, some coops	The government provides renewable land concessions for 25 years	Aquaculture sector developing
Bahrain	Small intensive for finfish	Government	Part of government research facility leased to private sector	Emerging producer
Egypt	Trend → Smaller area, more efficient units (higher production/unit area)	98% private, traditional farms are family owned (account for 2/3 of employees)	Of area under aquaculture: 20% owned 75% leased 5% government	–
Iran (Islamic Republic of)	Small → Large-scale for finfish and for shrimp	Small scale = family owned; Shrimp is industry with vertical merge, Integrated = family owned	Usually ownership; Renting also possible if money is scarce	Larger farm has lower unit cost, and better management can be applied
Kuwait	No trend to larger	Tilapia farms privately owned; Sea cages = commercial	Ownership	–
Lebanon	Trout farming semi-intensive, small-scale operations encouraged; large commercial tuna farming planned	Family	Mostly ownership	30 restaurant owners invested

Country	Scale of operation and trends Small → large?	Ownership	Ownership vs. leasing	Comments
Libyan Arab Jamahiriya	Small-scale operations encouraged	Small operations privately owned; Government operations will be privatized	Mostly ownership; Leasing is new only one farm in 2005	–
Morocco	Small and large scale operations are important	Small- and large-scale operations are private companies, from family to commercial	Ownership	–
Oman	nd	Only one private commercial company	nd	Emerging producer
Qatar	nd	Private	nd	–
Saudi Arabia	No trend from small → large	Fish farms private; Shrimp farming = commercial	Fish farms owned = 75 Leased = 102	–
Syrian Arab Republic	Expand small-scale operations	Family concerns; Commercial operation rare	Most are privately owned; Cage farms are government-owned	Aquaculture yields high income compared to other agricultural activities
Tunisia	nd	nd	nd	–
UAE	Small- scale aquaculture and research Large-scale aquaculture	Government Private	Government – na Private – leasing	Emerging producer
Yemen	nd	German investors will set up largest fish farm in Middle East	nd	Emerging producer

Abbreviations: (na) not applicable; (nd) no data.

7.5 Demographic data and aquaculture trends

Among the demographic trends impacting aquaculture are: (i) competition for suitable land, leading to increased demand for setting-up aquaculture businesses (e.g. Egypt); (ii) population movement (e.g. from the central and northern parts of the country to the south where there are shrimp farms in the Islamic Republic of Iran), and (iii) energetic activities of Government supported aquaculture complexes attracting migration of workers (e.g. Islamic Republic of Iran).

8. TRENDS, ISSUES AND DEVELOPMENT

Data sources: The information in this chapter has been extracted from the NASOs and PAFADs submitted by the countries in the region, inputs from the regional expert workshops, unless otherwise specified.

8.1 Trends in aquaculture

Across the region, aquaculture is expected to grow and in some countries this growth is expected to be significant. Beyond this, there are no universal trends in changes in aquaculture since the individual combination of geophysical, economic and social factors in each country affects the farming systems that are practiced at present, and can be developed in future (see Table 8.1).

When the region is considered as a whole, four trends in aquaculture are apparent, although it should be emphasized that each is not universal across the region. The main trends in food fish production are (in order of number of countries reporting them): increased culture of marine species (12 of 15 countries), intensification (3 of 15) and more integrated agriculture-aquaculture (2 of 15 countries). Within marine species, both diversification and intensification are anticipated, driven by such forces as successful research by government laboratories providing technical knowledge and seed stock, availability of private investment, and potential export markets. Intensification is mainly driven by such forces as limited availability of land and water. Within non-food aquatic species, the main trend is toward production of ornamentals (3 of 15 countries) (e.g. Algeria, Islamic Republic of Iran, and Saudi Arabia) (Table 8.1).

Table 8.1 Trends in aquaculture in the Near East and North Africa region. *Data sources: NASOs and PAFADs.*

Country	Trends	Comments
Algeria	Aquaculture sector developing. <i>Diversification</i> of brackish and <u>marine</u> finfish and bivalve food species; start-up of ornamental fish breeding.	Diversification driven by need to improve domestic food supply, improve conditions in rural areas, and produce products for export.
Bahrain	DMR plans <i>intensification</i> of <u>mariculture</u> ; land-based closed systems and cages, mainly through private investments.	Currently the major seed supplier of commercially important local marine finfish to neighbouring countries in GCC.
Egypt	GAFRD plans <i>intensification</i> of 45–50 percent of present semi-intensive aquaculture; expansion slowing; smaller more efficient units; integrated desert agriculture-aquaculture encouraged.	<i>Intensification</i> prompted by limited availability of land and water; marine aquaculture not attractive to investors.
Iran (Islamic Republic of)	IFO plans <i>intensification</i> of carp, rainbow trout and shrimp; increased productivity, income, mechanization and larger farms; increased <u>mariculture</u> of finfish; possible expansion of integrated farming (agriculture-aquaculture); increase in production and diversity of freshwater ornamentals.	Entrepreneurs are preparing to invest in finfish cage culture.
Kuwait	<i>Intensification</i> of tilapia and marine fish farming; increasing <u>mariculture</u> .	Private investment in mariculture.
Lebanon	No trend to commercial trout farms; possible large-scale tuna farming; encourage joint-ventures; shrimp farming is recent.	Private initiatives for tuna farming.

Country	Trends	Comments
Libyan Arab Jamahiriya	Small-scale operations encouraged; encouragement of <u>mariculture</u> .	Increased mariculture due to: limited freshwater, long coast, salty coastal groundwater free of pollution.
Morocco	Studies are underway to develop new means of cultivation in unused <u>marine</u> areas; introduction of tilapia; diversification of marine species including seaweed; establish bivalve hatchery; establish zoo-sanitary zonation to promote export; produce fish feed; preparation of legal framework for the aquaculture sector; government incentives for investment, and for shellfish fisherman to become fish farmers.	Natural physical properties and strong tidal waves are significant limitations for mariculture. Climate extremes limit freshwater culture.
Oman	Increase <u>mariculture</u> (shrimp, finfish cage culture and abalone).	Increased mariculture due to successful research by government laboratories, and applications from private sector.
Qatar	Develop a private sector for growout; Produce <u>marine</u> species.	Government research centre provides fingerlings.
Saudi Arabia	Intensive culture is system of choice; small- scale operations encouraged; <u>mariculture</u> , especially of shrimp; development of ornamental sector.	Intensification due to water supply limitation; small-scale operations encouraged due to their social aspects.
Syrian Arab Republic	Future development may include integrated freshwater production systems and <u>mariculture</u> , expansion of cage culture.	Private investments in marine cage fish farming are being established. Also private initiatives in tuna farming are under consideration.
Tunisia	Increased diversification of cultured <u>marine</u> species, particularly bivalves, octopus, shrimp, prawn and bluefin tuna. Controlled introduction of non-indigenous species.	Choice of species influenced by European markets.
United Arab Emirates	MAF aims to develop <u>mariculture</u> .	Aquaculture may become an important source of employment.
Yemen	Increase in <u>mariculture</u> – shrimp farming; German investment supports setting-up of largest fish farm in the Middle East; fast development of private sector.	German investment is crucial for the large farm that is being established; concerns are lack of funding, technical experience, training, and communication.

Note: In this table, mariculture is used in the widest sense to mean culture of marine species; this may include culture of marine species in very low salinity waters, not necessarily only in full strength seawater.

Abbreviations: (**DMR**) Directorate of Marine Resources; (**GAFRD**) General Authority for Fish Resources Development; (**IFO**) Iranian Fisheries Organization; and (**MAF**) Ministry of Agriculture and Fisheries.

Marine aquaculture of both finfish and crustaceans has increasing in the region, and the increase is expected to continue (Table 8.1). Furthermore, several countries (Bahrain, Oman, both emerging regional producer countries; and Saudi Arabia, a more established regional aquaculture producer)

have identified increased mariculture as a specific goal within the sector. Bahrain will focus on production of marine fish fingerlings for sale, release and semi-commercial mariculture activities, and Oman and Saudi Arabia will focus on production of marine shrimp. In Saudi Arabia, production of shrimp jumped from 51 tonnes in 1990 to 9 160 tonnes in 2003. Other mariculture trends of note are development of marine cage culture in Iran (Islamic Republic of), production of gilthead seabream fingerling in Kuwait (also for export within the region), and tuna fattening in Oman. In Tunisia, the trend towards increased diversification of marine species, including bivalves, octopus, shrimp and tuna, is, in part, influenced by European markets.

Across the region there are no general trends in the scale of aquaculture production. An increasing scale of operations, for both finfish and shrimp, is planned in Iran (Islamic Republic of), prompted by lower unit costs and application of better management practices. However, a trend to smaller and more efficient units is seen in Egypt (Table 8.1).

8.2 Non-indigenous species recently introduced into aquaculture

Growth of the aquaculture sector has involved the adoption of new species, some of which are endemic to a particular country and newly farmed in that country, while others are non-endemic to a particular country and are imported for aquaculture purposes. Within the last ten years, many countries in the North Africa and Near East region have imported non-endemic aquatic species, particularly finfish, which are either already established as an integral part of aquaculture production, or are being studied as potential aquaculture species.

Six of these newly introduced species are already contributing significantly to aquaculture production at the national level in some countries: (i) gilthead seabream, *S. aurata* (which now forms the majority of production tonnage in Oman and the United Arab Emirates, and was in 2005 introduced in Bahrain for nursery rearing to supply seed to neighbouring countries); (ii) tilapia *O. niloticus* (which now forms the majority of production tonnage in Kuwait); (iii) and (iv) European seabass and meager (which form a significant part of production in Morocco); and (v) and (vi) penaeid shrimp and European crayfish *Astacus astacus* (the only crustaceans currently in commercial production in Lebanon) (Table 8.2).

As a further example of the importance of introduced non-indigenous species, one may cite the example of rainbow trout. Lebanon introduced rainbow trout in 1958, and this species now contributes more than 90 percent of production tonnage. Iran (Islamic Republic of) introduced this species in 1959 and it now contributes approximately 25 percent of production tonnage.

Some of the new potential aquaculture species are considered for non-consumption purposes such as a snail biological control programme, mosquito control, research and education, and ornamental fishes.

8.3 Driving forces

The most common factor driving the growth of aquaculture across the region has been, and probably will continue to be, the need to increase the domestic food supply, partly because the wild catch may be unstable or decreasing particularly for some commercially important species. In some locations, this need for domestic supply is further strengthened by increased fish products demand – triggered by increased per capita consumption (which may result from public education campaigns and advertising), and/or, an increase in number of consumers (due to increased consumer acceptance, population growth and increased tourism). Public education campaigns and advertising are particularly important in countries with large interiors, such as Iran (Islamic Republic of) and Saudi Arabia, where the population living inland is less familiar with buying, preparing, and eating fish, than is the segment of the population living along the coast. Thus the inland population represents new potential consumers for aquaculture products. Education and advertising for this group can come

into effect after the aquaculture industry in such countries with a large interior has reached a certain critical mass.

Table 8.2 Non-endemic species introduced for aquaculture that currently make a significant contribution to national production from 1995–2005. *Data sources: NASOs and PAFADs.*

Country	Gilthead seabream	Nile tilapia	European seabass	Meager	Penaeid shrimp
Bahrain	+	–	–	–	–
	29 million yolk-sac fry for nursery rearing (2005)				
Kuwait	+	+	–	–	–
	Unstable 426 tonnes (2002) 3.8 (2004)	110 tonnes (2000) 275 tonnes (2004)			
Lebanon	E	+	E	E	+
		3 tonnes			9 tonnes
Oman	+	–	+	–	–
	89% of total production (2004)		5% of total production (2004)		
Saudi Arabia	–	2 400 tonnes (2003)	–	+	–
UAE	+	–	+	–	–
	442 tonnes (2003) 511 tonnes (2004)		60 tonnes (2003) 14 tonnes (2004)		

Abbreviations: (+) introduced; (–) not introduced; (E) endemic.

Other forces driving aquaculture in the region include the need to increase export revenues, and support of socio-economic programmes via provision of employment and affordable nutrition in poor regions. Growth in aquaculture has less commonly been triggered by its favourable effects in environmental amelioration, and by the need to raise species for restocking into the wild and for recreation; this is particularly important for locally endangered species. Furthermore, a high price can also be an important driving force in aquaculture.

From within the sector, technical and organization progress, and improvements in infrastructure, are also important driving forces. Suitable funding (government and/or private), investment, and an organized legal framework (including effective certification and licensing) are crucial to support aquaculture across the region.

8.4 Priority issues

Successful and sustainable development of aquaculture can be limited by a wide variety of factors in the Near East and North Africa. Some of these are beyond our immediate control, such as civil war

and drought which have directly affected Lebanon and Iraq in the last decade. Other factors can be influenced, whether in a limited way such as land and water availability, or more extensively such as technical challenges, underdeveloped markets, poor disease monitoring, complex administrative procedures and scarce funding (from bank credits, subsidies, or investment), and inadequate training and research.

Successfully addressing four key priority issues is essential for the continued growth of aquaculture in the Near East and North Africa: (i) farming systems, technologies and species, (ii) marketing and processing, (iii) health and diseases, and (iv) policies, legal frameworks, institutions, and investment. While there is a consensus among countries in the region about the importance of these issues, the relative importance of each of the four issues will vary from country to country, dependant largely upon the state of development of the aquaculture sector in individual countries (whether it is developing or developed).

Farming systems, technologies and species

Limited availability of suitable sites for new aquaculture activities is a commonly encountered problem in the region, and may be manifest as shortage of land, insufficient freshwater, insufficient tidal fluctuation for land-based culture, and few marine sites suitable for existing systems. In some cases, the pressure to find suitable sites is because few or no sites exist, and in other cases suitable sites may exist, but access to them is restricted due to concomitant needs of other user groups such as agriculture, human settlement, tourism, transport, and conservation. Further challenges for some countries, particularly those with a developing aquaculture sector, are adequate supply of finfish fry/fingerlings and shellfish spat, and reliance on imported fish feed. Lack of domestic hatcheries means reliance on imports, and erratic supply may cause problems with the production cycle. Furthermore, there is recognition that more research is needed to identify local endemic species of finfish and shellfish that are suitable for aquaculture, in order also to avoid the introduction of exotic species with the avoidance of unknown environmental impacts and to ensure customer acceptability of the products produced.

Some potentially suitable sites cannot presently be used because technologies are not currently available that are suitable for such sites; this is particularly true for some marine sites in North Africa, including Egypt. A further land use limitation in countries where freshwater is very limited, such as Algeria, Lebanon and the Syrian Arab Republic, is that land and water use are not yet efficiently integrated and optimized among the different user groups (agriculture and aquaculture), and resources are under utilized. Lack or limited domestic hatchery facilities may be due to lack of financial support – whether government or private; beyond this there may be technical challenges with raising the young of some species.

Research and technology transfer between countries, are seen as key solutions to developing suitable new technologies that can be adopted for use in the remaining available sites, particularly those in the marine environment. Emphasis will need to be placed on finding systems that are suitable for the specific geographic locations, and level of technology available. To address environmental concerns, undertaking Environmental Impact Assessments for aquaculture projects, and promoting farming systems that make rational use of water, are important solutions. For the latter, integrated agriculture-aquaculture projects can play a key role, and are of growing importance in such countries as the Syrian Arab Republic.

With regard to the possible adoption of genetically modified organisms into aquaculture in the region, this is unlikely, and would be considered cautiously, based on bio-safety regulations in individual countries.

Marketing and processing

Currently, there are under-used markets within individual countries and outside individual countries that represent future sources of sales for food products from aquaculture. At present some of these markets are under used because they may be regions where fish is not traditionally part of the diet (such is the case with many rural areas), or where certain kinds of fish are not appreciated (such is the case with freshwater fish in Morocco), or they may be countries with rigorous import regulations, such as the European Union. A further challenge is seasonality of supply, when markets may be flooded with a single species at certain times of year, with consequent reduction in price. Difficulties with pricing, in another instance manifest as high prices that are not competitive, comes about due to disproportionately high unit costs of production. In some cases, subsidies in the European Union country can adversely affect the competitiveness of the price of aquaculture products from the Near East and North Africa region. Such has been the case for Morocco, where the price of the main culture species, gilthead seabream and European seabass has declined, and this, coupled with subsidies given to producers in Europe, has meant that production has decreased, and some farms have ceased production.

There is a need to promote consumption of fish, so that number of consumers and per capita consumption will increase. This can be achieved by adoption of comprehensive marketing strategies including local marketing, increased advertising, and public education about the health benefits of eating fish. Improved labelling and traceability should also increase consumer confidence in the product, and may be particularly effective for promotion of new products such as organically raised fish (currently considered to be an important potential niche in the market). The challenges posed by seasonality of supply can be addressed in part by adding value-added products (such as tilapia fillets), with a longer shelf life compared to that of fresh fish, exporting surplus fish, and diversification of farmed species thus offering the consumer increased choice. For reducing high per unit production costs, increasing output and offering subsidies may be solutions. Overall, there is a need for improved processing facilities and transport infrastructure, collaboration of existing trade networks within the region, and more effective participation by producer associations and other non-government organizations.

Health and diseases

Infectious disease is a significant limiting factor in aquaculture in the Near East and North Africa, with a variety of negative impacts including: (i) causing direct economic loss due to acute and chronic losses of stock; (ii) causing economic loss due to reducing or disallowing exports (directly if infectious organisms are present, and indirectly via drug and other treatment residues); (iii) transmission to wild stock, and less commonly, and (iv) transmission to humans. Other health problems, such nutritional problems and deformities, may also cause economic losses, but are – at present – less pervasive than infectious diseases. Health issues are of increasing importance due to intensification of aquaculture, and increasing movement of aquatic organisms within and between countries.

The most pressing problem is inadequate disease monitoring: among the 17 countries in the region, less than half report that their disease monitoring capabilities and programmes are adequate. Monitoring is reported to be adequate only in Egypt, Iraq, Morocco, and Tunisia; sometimes adequate in Iran (Islamic Republic of) and in Libyan Arab Jamahiriya; and inadequate in Algeria, Lebanon, Saudi Arabia and the Syrian Arab Republic. Within the emerging producer countries, disease monitoring programmes are currently planned for the emerging producer countries of Bahrain, Kuwait, Oman and Qatar; they are not yet planned for the United Arab Emirates or Yemen. Other key regional deficiencies in disease awareness and management are difficulties in accessing information, an absence of specialists, and a scarcity of suitably qualified diagnostic laboratories. The latter is of particular concern for virus diseases, which are considered to be under reported in the region, in part due to limited detection and diagnostic capability. Several countries send diagnostic samples outside the region for work up, including to Great Britain and the United States of America. Furthermore,

quarantine procedures and facilities are inadequate in some instances, and in a number of countries there is no regulation or legislation pertaining to chemicals and drugs approved for use in aquaculture.

In order to address these deficiencies, the following solutions are urgently needed: training in correct sample collection and preparation, distribution and effective use of manuals for identification of etiological agents, establishment of – and adherence to – a regional code of conduct (or other recognizable standards of practice), implementation of a regional alert/notification system for disease outbreaks, and adoption of effective quarantine practices. Overriding all of this, there is an urgent need to establish a comprehensive regional centre of expertise in fish health, with a capability for undertaking virology work.

Policies, legal frameworks, institutions and investment

Effective policies, legal frameworks and institutions are necessary prerequisites for the development of aquaculture; however across the region there are circumstances where policies were or are absent, obscure, or complicated, thus hindering aquaculture. Obstacles include numerous agencies needing to be consulted for addressing single or limited issues, long periods of time being required for bureaucratic procedures, contradictory laws, rigid policies, and a lag between the speed of development of the administrative framework supporting the aquaculture industry and the faster speed of development of the aquaculture industry itself. In parallel, there has often been, and in some instances continues to be, a lack of funding, both from governments for initial research and development and subsequent subsidies, and from private investors.

Some key challenges in the aquaculture sector in any one country may have to confront are a lack of coordination between the multiple agencies that share regulatory responsibility, legislation that may not be in harmony with present and future status of the industry and with other related legislation, and unclear and or conflicting priorities within the policy making and regulatory spheres. Furthermore, the coordination of the policies and laws pertaining to aquaculture between the 17 countries in the region is widely – but not universally – considered to be inadequate (attributable in part to diverse legislative systems, aquaculture standards and priorities in different countries). In some instances investors may be deterred from investing in aquaculture as it is a relatively new business, and is sometimes perceived as having a negative impact on the environment.

To rectify these problems, a multi-faceted approach is needed including: development of a comprehensive management plan for aquaculture development for countries where such a plan does not already exist, regular dissemination of information by the sector to the regulatory agencies in order to promote a unified understanding of the needs of the sector, conducting regular meetings between different regulatory agencies and between the agencies and their constituents in order to achieve exchange of information and improved coordination, harmonization of identification of priorities, harmonization of and possible amendments to laws relating to aquaculture, and promotion of active interregional coordination of national policies as far as is practicable.

9. COUNTRY OVERVIEWS

Data sources: The information in this chapter has been extracted from the NASOs and PAFADs submitted by the countries in the region unless specified.

9.1 Introduction – clustering

The profiles of the aquaculture sector within the 17 countries of the region shows that while there is a great heterogeneity, there are similarities between some countries, and countries can be clustered together based on similar current aquaculture profiles. It is of interest to note that production amount is not directly linked to number of years that the industry has been established, and that for some countries consideration of social aspects plays an important role in determining the strategy and development of aquaculture activities.

Table 9.1 Clustering of countries according to their current aquaculture profile showing the year or decade when commercial production started. *Data sources:* NASOs and PAFADs.

Group	Current production	Length of establishment of aquaculture	Importance of social aspects in aquaculture operations	Country North Africa	Country Near East
A	High	Long	Moderate (Egypt and Iran, Islamic Republic of)	Egypt (1930s)	Iran (Islamic Republic of) (1923)
B	Moderate	Long – moderate	High (Syria)	Syrian Arab Republic (1950s)	Saudi Arabia (1982)
C	Low	Long	High High High High	Lebanon (1930s) Libyan Arab Jamahiriya (1970s) Morocco (1950s) Tunisia (1960s)	–
D	Low	Recent – emerging	– – High Medium – –	Algeria (1980s)	Bahrain (2000) Kuwait (1992) Oman (2003) Qatar (2004) UAE (2001) Yemen (2005)

Production: high >100 000 tonnes/year (approx.); moderate 10 000 tonnes/year (approx.); low >2 500 tonnes/year (see also Table 2.1).

Length of establishment: long (1930s–1950s); intermediate (1960s–1980s); recent (1990s); emerging (2000–present).

Note: data not available for Jordan and Iraq.

The countries within the region can also be clustered according to the priority afforded to their aquaculture development, be this low, moderate or high. This aspect has been discussed in section 6.1 (strategy).

9.2 Individual reports

Algeria. Aquaculture in Algeria is in its start-up phase. In 1999 the Ministry of Fisheries and Fishing Resources was established, providing support for the economic development of the sector, including encouragement of private investment. At present, more than 90 percent of production comes from extensive production of carp raised in inland reservoirs; mussels are of minor significance. Species for future food production focus include five finfish, i.e. the flathead grey mullet (*Mugil cephalus*), Nile tilapia (*Oreochromis niloticus*), European seabass (*Dicentrarchus labrax*), gilthead seabream (*Sparus aurata*) and catfish; and two bivalve species, i.e. the Pacific cupped oyster (*Crassostrea gigas*) and the Mediterranean mussel (*Mytilus galloprovincialis*). Ornamental fish breeding is also in a start-up phase. The goals of aquaculture development include contributing to the availability and security of the domestic food supply, improving living conditions in the rural areas, and producing products suitable for export. Annual growth in production in the decade 1994–2003 was 2.3 percent.

Bahrain. Commercial aquaculture (mariculture) is in its infancy stage, and has very good opportunities for development in the near future. In 2005, the government owned National Mariculture Centre was dedicated, and will carry out applied scientific research. Mass propagation of seeds of commercially important local marine finfish (6 species) (with a focus on sobaity seabream), and shrimp (1 species), has already been achieved. The Kingdom is emerging as a major marine finfish hatchery seed producer and exporter in the region. Floating cage culture and intensive closed aquaculture systems are the most promising farming systems for the country, and are being studied. Commercial production was tested in 2000, but discontinued after two years; commercial production began again in 2005.

Egypt. This country is the leading regional producer (79 percent of regional tonnage, and 58 percent of regional monetary value, in 2003). Aquaculture is driven, in large part, by the reliance of the population on fish as a source of protein, since grazing land is very scarce. Significant development and expansion of aquaculture has occurred in the last two decades, the sector has witnessed a sharp increase in production since 2000, and growth is currently expected to exceed that targeted in the government plan. Higher levels of technology are now being applied, associated with a change in the structure of the fish farming community, from traditional farmers to investors with more sophisticated scientific backgrounds. There has also been a rapid expansion in support activities, such as feed mills and hatcheries. A total of 14 species of finfish and two species of crustaceans are farmed. Most cultured fish are either freshwater or brackish species, with Nile tilapia being the most important, the dominance of this species being promoted by the availability of all male stock. Most farms are semi-intensive brackish water pond farms, however intensive culture in earthen ponds and tanks is developing very fast, compensating for reduced land availability. Aquaculture is considered to be the only available option for bridging the gap between production and consumption of fish in Egypt, and presently contributes 50.8 percent of the total fish production. All aquaculture production of food fish is currently for consumption within the country, although export will begin in 2005/2006. Following issue of the first license in 2005, export of locally bred, imported, freshwater ornamentals is growing fast. Egypt plans to produce and export organically raised fish before 2012. Annual growth in production in the decade 1994–2003 was 25.8 percent.

Iran (Islamic Republic of). This country is the second leading regional producer (16 percent of regional tonnage, and 26 percent of regional monetary value in 2003). Aquaculture production has expanded significantly since 1980. The great diversity of geography and climate within the country allows for a great diversity of aquaculture practices. The industry began with fish stock enhancement in the Caspian Sea in 1923, and has continued with semi-intensive aquaculture of Chinese carp, rainbow trout (the first farm was established in 1962), and more recently also of both local and introduced shrimp species (shrimp farming began in 1992) and marine fish (in 2004). Hatcheries have been established for raising bony fishes and sturgeon fingerlings, and the Iranian Fisheries Organization has established research centres to support the industry. All aquaculture activities from feed production to marketing are carried out by the private sector, with government support. Aquaculture contributed 27 percent to total fish production (in 2004), and an increase in this share is planned. Aquaculture production is mainly for the domestic market (92 percent); shrimp and caviar constitute the principal exports. Annual growth in production in the decade 1994–2003 was 15.1 percent.

Iraq. Iraq has extensive and varied aquatic resources which can be used for aquaculture production. However, between 1985 and 2003, these resources were not integrated into the industrial development management plan, and their uncoordinated use did not yield sufficient production to satisfy domestic demand. Between 1970 and 2003, aquaculture declined in Iraq, from 1 609 farms to 534 farms; production was limited by poor management, high production costs, and major losses due to emerging viral diseases. Pond rearing was, and is, focussed on intensive closed systems using concentrated zooplankton for culture of common carp, grass carp and silver carp; all farms belong to the private sector. In recent years, the number of hatcheries has increased; in 2003 there were 25 hatcheries producing carp fingerlings. At present, use of aquatic resources for aquaculture continues in the absence of a management plan, and with limited economic and technical resources. However, the

Government plans to establish an agency that will regulate and enhance the sector. Other necessary driving forces for development include investment and research. There was a drop in aquaculture production in the decade 1994–2003, with an annual growth of –10.6 percent.

Jordan. Detailed information on status and development (NASO and PAFAD) is not available. Annual growth in production in the decade 1994–2003 was 25.2 percent.

Kuwait. Aquaculture is a new activity in Kuwait, and currently focuses on three species: tilapia (*Oreochromis niloticus*), gilthead seabream (*Sparus aurata*) and sobaity seabream (*Sparidentex hasta*). Tilapias are raised in concrete tanks using brackish water, the water is then used for irrigation of crops, mainly Alfalfa (*Medicago sativa*). Annual production of tilapia has increased from 2000 to 2004. The gilthead seabream and the local sobaity seabream are raised in floating cages in Kuwait Bay. In the case of the latter species, the eggs are imported from France and Greece. Gilthead seabream fingerlings are exported to Oman and the United Arab Emirates, sobaity are raised to a market size of 450 grams. Production of sobaity seabream has been unstable during 2000–2004. A new company has just begun production of sobaity seabream, sha'm and hamoor (grouper) fingerlings for export. The Government is supporting aquaculture as a priority, and the sector has been identified as a potential source of seafood to augment the countries future demand for fish. Commercial production began in 1992.

Lebanon. Freshwater aquaculture has been practiced in Lebanon since the 1930s, and is now focused on semi-intensive production of rainbow trout (which accounts for 90 percent of production). Recent initiatives include tilapia farming, and marine aquaculture, including a shrimp farm. The Ministry of Agriculture (MOA) currently is undertaking pilot production of marine species at the Oceanographic Institute in Batroun, and provides an extension service to growers at the Anjar Centre for Aquaculture. Aquaculture contributes 27 percent of the fish for domestic consumption, and this is considered to be below potential. Research to support improvements in aquaculture is weak and currently not adequately coordinated. Annual growth in production in the decade 1994–2003 was 16.5 percent.

Libyan Arab Jamahiriya. Freshwater aquaculture (carp and catfish) began in the 1970s and although several other freshwater species were raised successfully, there was little demand from local consumers, and this segment of freshwater aquaculture did not develop further. In the 1990s tilapia were introduced and were quickly accepted by consumers, and are now raised in irrigation ponds in agricultural farms. Mariculture began in the early 1990s, and since 2000, new farms have been established. Three species are raised namely the European seabass, gilthead seabream and mullet (although the latter is of minor importance). Initially fish were collected from the wild for further on-growing, subsequently fingerlings were imported, and since 2003 several hatcheries are in operation. Bluefin tuna farming was started in 2003 by the private sector. The introduction of qualified professionals has been helped by the establishment, in 1996, of the Aquaculture Department at the Faculty of Agriculture at Alfateh University. Aquaculture could have a good potential for successful development in the country. Annual growth in production in the decade 1994–2003 was 32.6 percent.

Morocco. Morocco has two seaboard, and rich coastal aquatic resources. However, despite this, the country does not have a strong tradition of aquaculture, in part due to the fact that there are relatively few suitable natural sites. Commercial aquaculture began in the 1950s. More recently, through the Department of Marine Fisheries, potential aquaculture developments are being studied, along with identification of a policy of aquaculture development, and analysis of necessary support measures. Development would be enhanced by species diversification, introduction of new species, strengthening the sanitary zonation for fish and shellfish, a fish feed production facility, reduction of administrative barriers, providing economic incentives, inclusion of aquaculture in integrated regional plans, good training for operators in the sector, and more research. Shellfish culture is a promising future development. Organisation of those involved in aquaculture has strengthened the industry. Currently, aquaculture – dominated by salmonids and carp – plays only a very marginal role in total fisheries production (contributing <1 percent). Annual growth in production in the decade 1994–2003 was 0.6 percent.

Oman. Aquaculture in Oman is in its infancy. Commercial cage culture mainly produces gilthead seabream, supplemented by seabass and yellowfin tuna. Yellowfin tuna fattening has recently begun. In 1992, the government established the aquaculture laboratory at the Marine Sciences and Fisheries Centre. In 1996, the aquaculture committee was established with members from the Ministry of Agriculture and Fisheries, and other relevant ministries; this committee is responsible for issuing licenses to companies as well as monitoring their activities. In 2004, the aquaculture regulations were issued. A new centre for aquaculture is planned. There are good opportunities for strong development in the future, particularly marine shrimp projects; the first shrimp farm is scheduled to commence operation in 2006, with production primarily for export. Commercial production began in 2003.

Qatar. Experimental aquaculture activity in Qatar started in 1988 with the construction of a small government experimental aquaculture research project, the Doha Aquaculture Centre, which focused on rearing local species, especially Rabbit fish. In 1998, a new program began for study of larval culture of local fish species (Rabbit fish and yellow seabream – the latter for restocking activities and for rearing to market size). In 2001, a new hatchery was built that included an algae and rotifer production unit. The most common fish cultured in Qatar is tilapia, which is reared in extensive pond culture; commercial production of this species begins in 2004.

Saudi Arabia. Commercial aquaculture in Saudi Arabia currently produces (in order of decreasing tonnage), shrimp, Nile tilapia, catfish, seabass, rabbitfish, grey mullet and a variety of ornamental fish species. Freshwater farms are currently established within existing agricultural projects, thus efficiently using water. Marine aquaculture is rapidly expanding, especially in shrimp farming. The Kingdom has a tremendous potential for aquaculture, and the Ministry of Agriculture has identified aquaculture for intense focus, and proposes to develop it in all coastal and interior areas. If successful, such efforts will augment the seafood supply, increase self sufficiency, and may increase export production of aquatic products. Aquaculture is considered to be an attractive field for foreign investment in comparison to other development fields. Annual growth in production in the decade 1994–2003 was 20.3 percent.

Syrian Arab Republic. Aquaculture begun in the Syrian Arab Republic in the late 1950s is restricted to warm freshwater finfish culture, principally of common carp and tilapias, supplemented by the African catfish, grass carp and silver carp. Pond fish culture dominates. Aquaculture presently contributes 50 percent to total fish production. One of the factors driving the wide expansion of aquaculture is that it provides a good living standard in comparison with other agricultural activities. Aquaculture is also proving to be a suitable tool for amelioration of environmentally degraded lands, as exemplified by the 40 fish farms established in the salinized lands in the Euphrates basin that are no longer suitable for agriculture. Future aquaculture development may include integrated production systems as well as culture of marine fish; brackish water aquaculture remains limited. Annual growth in production in the decade 1994–2003 was 5.3 percent.

Tunisia. Aquaculture efforts in Tunisia began in the 1960s, with raising shellfish. In 1985, the National Aquaculture Centre was established. Currently the most important species are the European seabass (loup), gilthead seabream (daurade), mussels and oysters, a variety of freshwater fish species, and bluefin tuna. A general trend in the sector is towards higher diversification of cultured species, including farming new species such as the carpet shell, octopus and shrimps in order to reduce competition with the European market. During the last decade, development of aquaculture was strongly supported by numerous government measures. A particular focus is to improve income, employment and food supply for rural areas. Aquaculture is developing slower than that expected by the public authorities, in spite of the great potential that has been identified (current annual production is only about 1/5 of the 20 000 tonnes of potential production). Annual growth in production in the decade 1994–2003 was 7.2 percent.

United Arab Emirates. Although aquaculture in the UAE is in its infancy, this country was one of the first among the GCC countries to start marine aquaculture. In 1984, the Ministry of Agriculture and Fisheries established the Marine Resources Research Centre (MRRC), and aquaculture has been

one of its significant projects. Achievements include production of fingerlings of locally popular fish such as rabbit fish, grouper, mullet and seabream; in compliance with government policy, most of the fingerlings are released along the coastal waters. Broodstock of tilapia is held at MRRC, and larvae are distributed to farmers for growth in tanks or ponds; there is a surge in interest in this activity. Commercial scale aquaculture using sea cages focuses on gilthead seabream, seabass, and sobaity bream; market size fish are exported. Commercial production began in 2001.

Yemen. Aquaculture in Yemen is presently conducted at only two facilities, the Aquaculture Research Centre, and one private farm, with shrimp being raised in both facilities. In cooperation with the Egyptian National Institute of Marine Science and Fisheries, sites for possible shrimp culture are being investigated. Current targets species for research are shrimps, and among finfish, seed production research for gold-lined seabream. Future target species include black tiger shrimp, spangled emperor and blue spot mullet. At present the sector is underdeveloped due to lack of experience, finance and investments; to address this, both domestic and foreign investment are being encouraged. German investment will support establishment of a farm in the Rayan area (Arabian Sea/Gulf of Aden) in 2006, which will produce both shrimp and finfish, and is anticipated to be the largest aquaculture farm in the Middle East. Commercial production of the Indian white shrimp (*Penaeus indicus*) began in 2005 with a single private farm producing 380 tonnes in 2005.

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APPENDIX

**AQUACULTURE PRODUCTION IN 2003 – COMPARISON OF FAO OFFICIAL DATA
AND THAT DERIVED FROM THE NASOs AND PAFADs**

Country	2003	
	Official FAO data	NASO and PAFAD data
Algeria	476	240
Bahrain	3	2
Egypt	445 181	445 100
Iran (Islamic Republic of)	91 714	91 714
Iraq	1 500	No data available
Jordan	650	No data available
Kuwait	195	366
Lebanon ¹	790	600 (only includes trout)
Libyan Arab Jamahiriya	380	No data for 2003 391 tonnes in 2004
Morocco	1 538	1 078
Oman	352	352
Qatar	0	11
Saudi Arabia	11 824	11 859
Syrian Arab Republic	7 217	7 217
Tunisia	2 130	1 955
United Arab Emirates	2 300	566
Yemen	–	–
TOTAL	566 250	561 451²

Note: Differences in the production tonnage reported in the FAO statistics and in the NASOs and PAFADs may be accounted for by a variety of factors, including different reporting sources and routes, and submission of data for only authorized producers or both authorized and unauthorized producers.

¹Accurate statistics are not available.

²The sum includes the 2004 value reported by Libyan Arab Jamahiriya.

PART II

REPORT OF THE EXPERT MEETINGS ON THE REGIONAL ANALYSIS OF AQUACULTURE DEVELOPMENT TRENDS IN THE NEAR EAST AND NORTH AFRICA

Cairo, Egypt, 24–25 November 2005

Muscat, Oman, 28 November 2005

I. BACKGROUND

1. The Second Session of the Committee on Fisheries Sub-Committee on Aquaculture (COFI-SCA) held in Trondheim, Norway, from 7 to 11 August 2003 requested the Food and Agriculture Organization of the United Nations (FAO) to assess regional aquaculture development and to provide a prospective analysis of future challenges in global aquaculture. This initiative was intended to contribute towards a better understanding of the trends, processes and development prospects of aquaculture in individual countries, regions and worldwide, and to provide the basis for discussion of the long-term direction of the Sub-Committee's work. In response to this request, two FAO Expert Workshops on Regional Aquaculture Review in the Near East and North Africa were held to review aquaculture developmental trends and discuss the issues, opportunities and challenges for the sector in the region. The outcome of the review will be presented at the Third Session of the Sub-Committee on Aquaculture, which will take place in New Delhi, India, from 4 to 8 September 2006.

2. The meetings were preceded by a study of the National Aquaculture Sector Overviews (NASOs) and Perspective Analysis of Future Aquaculture Development (PAFADs) documents submitted by national experts in 16 countries of the region. The study, resulted in synthesis into the "Regional Review on Aquaculture Development for the Near East and North Africa Region in 2005" (hereafter referred to as the "regional review"), which provided both an overview of the main biological, economic and social aspects of aquaculture, and additional information required to encourage the development of the sector in each country. The regional review was prepared by Dr Sarah L. Poynton (FAO consultant).

3. The purpose of the workshops, organized by FAO, were to discuss and appraise the draft regional review, identify the main positive and negative forces impacting aquaculture in each country, and identify key priority issues challenging the region's industry, thus producing a synthesis of present and future development of aquaculture in the Near East and North Africa.

Dates and venues

4. In order to reduce costs and take advantage of the Second Meeting of the Regional Commission for Fisheries (RECOFI) Working Group on Aquaculture (WGA) (Muscat, Oman, from 29 to 30 November 2005) the Near East and North Africa Workshop was divided into two separate meetings and were held in Cairo, Egypt, from 24 to 25 November 2005 for the countries of North

Africa, and from 28 to 29 November 2005 in Muscat, Oman for the countries of the Near East. The adopted agenda of the workshops appear in Appendix A. The local hosts were the FAO Regional Office for the Near East in Cairo, and the Ministry of Agriculture and Fisheries in Oman. The workshops were co-chaired by Mr Alessandro Lovatelli (FAO, Fisheries Department) and Dr Sarah L. Poynton, regional reviewer (FAO consultant).

5. Both meetings were opened by Mr Lovatelli, FAO Fishery Resources Officer, Inland Water Resources and Aquaculture Service (FIRI), who welcomed the participants on behalf of Mr Ichiro Nomura, Assistant Director-General of the FAO Fisheries Department. He spoke of the aim of cooperation amongst the countries in the region to deal jointly, through regional cooperation, with the challenges of developing aquaculture. He also referred to FAO's support in promoting aquaculture in the region. He wished the participants a constructive and successful meeting.

6. Dr Mohamad I. Albraithen, Assistant Director-General and FAO Regional Representative for the Near East, welcomed the participants of the Cairo meeting and acknowledged their active support and inputs to the regional review. He then drew their attention to the importance of aquaculture for enhancing living conditions and improving nutrition in many rural areas, particularly in the southern Mediterranean countries. The participants were invited to highlight and recommend practical solutions to assist the development of aquaculture sector in the region. He further encouraged regional cooperation in the sector and offered the services of the FAO Office in Cairo for any support required by the meeting.

7. Dr Ahmed Hareb Al-Hosni, Assistant Director-General, Fisheries Research and Extension, Directorate General of Fisheries, Ministry of Agriculture and Fisheries, Sultanate of Oman, welcomed the experts from the RECOFI region, Iraq, Morocco, Yemen and FAO, and conveyed the Minister's best wishes for a successful and fruitful meeting. He underlined the importance given by Oman and its neighbouring countries to the development of aquaculture in order to secure food, income and job opportunities in rural coastal areas. He also emphasized the importance of RECOFI in encouraging cooperation among its Member countries in common issues of aquaculture.

Participants

8. Both workshops were attended by a total of 24 experts from 16 countries in the Near East and North Africa region. The Cairo workshop was attended by 10 experts from Algeria, Egypt, Lebanon, Libyan Arab Jamahiriya, Morocco, Syrian Arab Republic, and Tunisia, and a representative from the WorldFish Center. The Muscat workshop was attended by 15 experts from Bahrain, Iran (Islamic Rep. of), Iraq, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates and Yemen; one of the experts from Morocco attended both workshops. The list of participants is outlined in Appendix B.

II. MEETING PROCEDURES

9. Ten days prior to the meeting, all participants received the draft regional review (50 page document), a provisional agenda and a questionnaire inviting them to identify key priority issues to be discussed at the Workshop. The pre-meeting questionnaire is attached hereto in Appendix C.

10. The workshops followed an intense interactive format, opening with brief introductions by the participants, followed by a review and discussions on the draft regional review, identification of the positive and negative forces impacting aquaculture in each country in the region and identification of four key priority issues challenging aquaculture development in the region.

11. Participants provided constructive inputs to ensure that the regional review would reflect not only the current status of aquaculture across the Near East and North Africa but, more importantly, the challenges being faced and the solutions to be employed. An additional benefit fostered by the

collegial atmosphere was the identification of new linkages between countries to support each others needs, particularly regarding expertise.

12. The revised regional review incorporating the recommendations and information arising from the two workshops was further circulated to the participants for adoption.

III. PRESENTATION OF COUNTRY REVIEWS

13. The country experts attending the two workshops were invited to deliver, prior to the presentation and discussion of the draft regional review, a concise country summary to facilitate the participants. The outcome of the presentations clearly indicated that the development of the aquaculture sector varies considerably amongst the countries in terms of availability of resources, suitability of farming sites, state support and legal frameworks, existing logistical infrastructures, local private interest and investments, availability of technologies, as well as local and export market developments and consumer preferences for seafood products.

14. The experts further expressed their personal opinions regarding the major effects, both positive and negative, that have influenced, and probably will continue to influence, the development of the aquaculture sector in the region. Some of these observation are recorded below:

Mediterranean countries

Algeria

Negative

- Aquaculture matters handled by different government agencies and ministries
- A long-standing aquaculture development plan not adequately developed

Positive

- Ministry of Fisheries and Fish Resources established
- A development plan currently in operation and legal framework established
- Financial tools available for private investment

Egypt

Negative

- Competition for limited suitable land and water resources for aquaculture
- Marketing problems particularly for certain species in peak production periods

Positive

- Government policies exist to encourage development of the sector
- National economic growth has created demand for fish
- Technical expertise available through governmental institutes and private sector
- Strong local interest in both small and large scale aquaculture operations

Lebanon

Negative

- Lack or poor availability of national expertise and extension technicians
- Land and resource competition, particularly along the coast, with other uses
- No or poor generic marketing programmes and product development
- Adverse climatic and geographical conditions have discourage investment

Positive

- Establishment of a pilot aquaculture development and training centre

Libyan

Negative

Arab

Jamahiriya

- Local fish consumption limited and poor national market development
- Little private interest and investment in the aquaculture sector

Positive

- Government has created favourable investment climate
- Suitable sites identified and allocated for aquaculture development
- Aquaculture technologies introduced by some private entrepreneurs

- Morocco** *Negative*
- High production cost of farmed fish compared to north Mediterranean countries
 - Entry difficulties into the markets of the European Union countries
 - Suitable coastal aquaculture sites not often easily accessible
- Positive*
- Shellfish export possible due to compliance with health regulations and monitoring programmes
- Syrian Arab Republic** *Negative*
- Diminishing availability of water resources
 - Climatic conditions (such as droughts) have discouraged investment
 - Poor integration with agriculture activities
 - Financial incentives and technical support still inadequate
- Positive*
- Fish hatcheries being established and availability of fish fingerlings
 - Bilateral cooperation has increased production
- Tunisia** *Negative*
- Short experience and history in commercial marine and inland aquaculture
 - Land and resource competition, particularly along the coast, with other uses
 - Insufficient or inadequate feasibility studies to encourage private investment
 - Biotoxin issues affecting growth of bivalve aquaculture and marketing
 - High production cost of Mediterranean farmed fish and market competition
- Positive*
- Government has placed priority on the development of the aquaculture sector
 - A development plan for aquaculture has been prepared and is under implementation
 - Suitable inland/marine sites for aquaculture development have been identified
 - Strong applied research programmes in progress, and training centres established
- Gulf countries**
- Bahrain** *Negative*
- Insufficient state support of aquaculture research and development programme
 - Poorly monitored cross border movements of fish fingerlings
- Positive*
- Increasing interest in aquaculture projects from the private sector
 - Private sector investment and support of applied research activities
 - Government aquaculture centre producing fish fingerlings
- Kuwait** *Negative*
- No local fish feed industry and national feed requirements entirely imported
 - No or minimum coastal areas suitable for inland, coastal or offshore aquaculture
 - Slow governmental procedures delaying transfer of state farms to private sector
- Positive*
- Growing tilapia market request has encouraged private investment
 - Environmental regulations under development for sustainable operations of farms
- Oman** *Negative*
- Difficulties in obtaining aquaculture licences and access to suitable sites
 - Long project approval time from several government agencies
 - Level of technical expertise available still insufficient
 - More research is required to farm commercially suitable local species
 - Aquaculture sector relatively young

Positive

- Authorities established an aquaculture research laboratory in early 1990s
- A series of applied research activities supported by the Government
- Aquaculture development and management regulations issued in 2004

Qatar*Negative*

- Lack of adequate information to attract interest from the private sector
- Shallow waters off most of the country's coastline
- Limited suitable land availability for land-based aquaculture operations
- Technical training is still required to develop local expertise in aquaculture
- Minimum site selection for aquaculture has been carried out by the authorities

Positive

- A national aquaculture centre has been planned and will be established
- The aquaculture centre will supply fingerlings and technical expertise

Saudi Arabia*Negative*

- Limited freshwater resources to develop aquaculture using freshwater species
- Sites for aquaculture development not identified and discouraging investors
-

Positive

- Long marine coastline to develop near and off-shore mariculture
- State authorities allocating sites for aquaculture development in the Red Sea
- Inland aquaculture and mariculture relatively long history
- Sites along the coastal areas accessible through good road infrastructures
- Successful commercial companies attracting more interest from the private sector

United Arab Emirates*Negative*

- Insufficient or inadequate feasibility studies to encourage private investment
- Imported aquaculture technologies need to be adapted to local conditions
- Poor or insufficient technical capacity among government technical officers
- Insufficient government support to develop the aquaculture sector

Positive

- Interest among the private sector strong and funding not a constraint

Yemen*Negative*

- Lack of information on suitable sites for coastal aquaculture development
- Long project approval time and difficulties in obtaining aquaculture licences
- More research is required to farm commercially suitable local species
- Poor governmental financial support in research and training
- Inadequate local availability of shrimp feed and high import costs

Positive

- Strong interest among private investors particularly in shrimp aquaculture
- Marine aquaculture centre established and supported through bilateral programme
- Governments encourages investments in commercial aquaculture projects

IV. PRESENTATION AND DISCUSSION OF THE DRAFT REGIONAL REVIEW

15. The regional review of the state of aquaculture was presented on the basis of the country reports. The review included information on the aquaculture sector of 17 countries of the Near East and North Africa (Algeria, Bahrain, Egypt, Iran [Islamic Republic of], Iraq, Jordan, Kuwait, Lebanon, Libyan Arab Jamahiriya, Morocco, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Tunisia, United Arab Emirates and Yemen). These countries together have a total area of approximately 11.2 million

square kilometres with a current population of about 280 million inhabitants. In 2003 the region's total aquaculture output was estimated to be in the region of 570 000 tonnes, valued at some US\$ 1.1 billion.

Assembling the regional review

16. The regional reviewer, Dr Poynton, explained the process of assembling information from the NASOs and PAFADs into the draft regional review document. It was noted that the layout and format of the terms of reference (TORs) for both NASOs and PAFADs were somewhat different from those of the regional review, and each of the three TOR documents had a distinct numbering system for each section. In synthesizing the country reports into the regional review, it was necessary to harmonize the different numbering systems, with priority being given to the TORs given for the regional review, and then to reduce repetition of information. An additional, penultimate section, entitled "Country perspectives" was added to the regional review, in which a brief overview of aquaculture for each country is outlined.

17. The NASO and PAFAD documents were available for 15 of the 17 countries in the region. No documents were received from Jordan or Iraq, however in the case of Iraq information was made available by the country expert during the Oman workshop. Thus, the majority of the information presented in the regional review was based on data from the 15 countries which responded, with the exception of Section 2 on "Production, species and values". For this section it was essential to provide an overview for the entire region (all 17 countries), thus official FAO statistics on production and values were used (values were taken from 1994 and 2003 to determine temporal trends, and 2003 for more recent information).

18. Approximately 10 days prior to the commencement of the workshops the draft regional review was circulated to all participants to allow them to review and edit the document. The regional reviewer presented an overview of each of the 9 sections of the Review at both workshops and summarized the main points and the status of the draft. The presentation was followed by a request for specific information which participants were unable to obtain. The experts were also asked to provide additional comments and suggestions.

19. Some of the major issues raised in each of the sections of the regional review are reported below:

20. Section 1 – *Characteristics and structure of the sector*: Modern aquaculture in the region is relatively new, and has shown remarkable growth over the last decade, from approximately 97 000 tonnes in 1994 to 570 000 tonnes in 2003, with a concomitant rise in value from US\$235 million in 1994 to US\$1 063 million in 2003. Nearly all countries foresee to increase their production in the future. The leading producers are Egypt and the Islamic Republic of Iran; there are also a number of newly emerging producer countries in the Near East. Aquaculture is dominated by the production of fish for human consumption, the most important species groups are tilapias, carps and miscellaneous coastal fishes; among crustaceans, only the Indian white prawn presently plays a significant role.

21. The discussion of this first section pointed out: (i) the importance of emphasizing differences between countries within the region, to ensure that the regional picture was not dominated by the situation in the major producer countries of Egypt and Iran (Islamic Republic of), and (ii) clarification was required with regards to mariculture, as this could be interpreted as culture of marine species or culture of species in seawater. The experts were also asked to provide additional information on the role and importance of genetically modified organisms, and genetically enhanced organisms, in aquaculture.

22. Section 2 – *Production, species and values*: During 1994–2003, the tonnage of regional production increased five fold, and the value increased four fold. Egypt and Iran (Islamic Republic of) accounted for 79 and 16 percent of the tonnage and value, respectively. Most countries had increased production, and expect to continue to do so. In the Near East there are a number of countries emerging

as producers: Bahrain, Kuwait, Oman, United Arab Emirates and Yemen. The contribution of aquaculture to total fisheries production increased from 4.5 to 18.7 percent. From country to country there were great differences in the share of total fishery production accounted for by aquaculture, with particularly high contributions (approximately 50 percent) in Egypt, Jordan and the Syrian Arab Republic.

23. The discussions pointed out: (i) as a parameter of increased aquaculture production, tonnage was the most appropriate, with the value being a secondary indicator. The contribution of aquaculture to total fisheries production should not be used as an indicator of aquaculture production, since the percentage contribution was dependant not only on aquaculture production but also on wild catch, and (ii) for some countries, the data for production tonnages and values in the official FAO statistics were used for compiling this section did not concur with the data supplied in the NASOs. It was agreed to include an appendix in the regional review in which production tonnage from official FAO statistics and the NASOs would both be presented.

24. Section 3 – *Economics and trade*: Within the last decade, more than half of the countries in the region have seen an increase in the percentage contribution to fisheries made by aquaculture. The major trends in food fish production are increasing culture of marine species, intensification and integrated agriculture-aquaculture. Amongst non-food aquatic species, the main trend is towards increasing production of ornamentals. Of the nine exporter countries, most export fresh fish for human consumption to other countries within the region. It was noted that although exports are imminent the largest producer country, namely Egypt, does not at present export, as domestic demand is high.

25. During the discussions it was noted that many countries do not report aquatic products from aquaculture and wild caught fisheries separately, thus there are limitations to the availability of data. Participants were asked to supply information additional to that requested in the TORs for NASOs pertaining to import and exports (e.g. products, sources, destinations, certificates and permits). Printed matrices were distributed to each participant, so that this additional data could be collected during the workshops.

26. Section 4 – *Contribution to food security, access to food and nutrition*: Across the region consumption of fish is generally lower than that of poultry and red meat, although this varies greatly within any individual country. Both absolute and relative consumption of fish vary between countries, with absolute consumption being highest in Oman and the United Arab Emirates. Fish consumption is increasing in some countries, often encouraged by effective public education campaigns.

27. In the discussion, the experts were informed that the phrase “Food safety” had been removed from the title of this section, since this term usually implies aspects of the food safety pertaining to suitability for human consumption. As this aspect was beyond the remit of the regional review, the term was removed from the title of the section. Discussions pointed out that increased tourism is able to stimulate local demand for fish and hence be a driving force for the industry.

28. Section 5 – *Environment and resources*: The total area under aquatic production across the region is estimated to be around 620 000 hectares. Mangroves are present in approximately half of the countries, and these vulnerable ecosystems are afforded protection. A few countries are currently establishing actions and policies to safeguard these special coastal zones. Some of the newly introduced species include gilthead seabream, tilapia, European seabass, and penaeid white shrimp. Diseases have impacted both on finfish and shellfish aquaculture, with bacterial and parasitic diseases being especially important in the former, and viral diseases being especially important in the latter. Environmental degradation such as algal blooms also contributes to losses. Disease surveys and monitoring are not adequate in some countries. Although nearly 465 000 tonnes of fish feed are produced in the region each year, lack of domestic production is a key factor limiting aquaculture in some countries.

29. The experts were requested to provide additional information on hatchery production of seed of important species and the future needs, challenges and demands. The discussions pointed out that (i) consideration of special environments should, in addition to the mangroves already included in the Review, also consider corals; and (ii) clarification was needed on the terms “new” and “introduced” species that were new in aquaculture versus those that were introduced into the country, and for the latter whether they originated within or beyond the region.
30. Section 6 – *Legal, institutional and management aspects*: The experts were informed that drafting of this section was in progress, and that a draft text would be sent to them for review and comment.
31. Section 7 – *Social impacts, employment and poverty reduction*: Across the region, it is estimated that aquaculture provides employment for 86 700 individuals. The ratio of economic support (the number of people supported by one employee) was estimated to be 1:5. Most employees are men, with various skill levels, from labourers to research scientists; employment can be both directly and indirectly related to aquaculture. The industry can play an important role in reducing poverty and unemployment, especially in rural areas. Despite the local importance of the industry, fisheries, including aquaculture, remain a small percentage of GDP and GNP for most countries.
32. The experts were invited to provide additional information regarding changes in ownership and whether employment in aquaculture compensated for jobs loss in capture fisheries. The discussions pointed out that the TORs did not specify whether ownership was related to the operation or the site, however it was presumed by the majority of participants that ownership belonged to the operation rather than the site itself. However, some of the information reported may not be comparable between countries, since the interpretation of the TORs may have differed.
33. Section 8 – *Trends, issues and development*: Across the region, aquaculture production is increasing, new species are being introduced, and there is increased culture of marine species. In many countries, an absence of domestic feed production facilities is seen as a major limitation. A major driving force in regional aquaculture development in some countries is the need to increase the reliability of domestic food supply.
34. The experts reiterated the importance of using production as the most reliable parameter of growth of the industry, and that aquaculture as a percentage of total fisheries production be used solely as a parameter for security of food supply. There was also a brief discussion considering algal blooms as a natural environmental event, rather than as a disease per se. The importance of recognising the key priority issues facing the industry was emphasised. The synthesis of the priority issue debates were incorporated in Section 8 of the regional review document.
35. Section 9 – *Country perspectives*: The regional reviewer informed the experts that an additional topic beyond those specified in the regional review TORs had been added, as a newly numbered “Section 9”, immediately preceding the references. The additional topic, entitled “Country perspectives” provides a one paragraph overview of the status and perspectives of aquaculture for each of the 17 countries in the region.
36. The Experts endorsed this proposal, on the basis this would be the only part of the regional review where the situation in individual countries would be represented.
37. Section 10 – *References*: The draft regional review contained only few citations. The Experts were invited to submit additional citations, such as review articles on the state of aquaculture in their individual countries, so that the reference section would be a more comprehensive source of information. It was nevertheless noted that the individual NASOs for the region, which will be posted on the FAO Web site, would include more citations relevant to a specific country. It was agreed that the reference list in the final regional review would also include the names of all experts who prepared the NASOs.

V. PRIORITIES

38. Structured debate of priority issues facing the aquaculture sector took place, with the experts identifying four major issues: (i) farming systems, technologies and species; (ii) health and diseases; (iii) policies, legal frameworks and institutions; and (iv) marketing and processing. Each issue was discussed as a matter of priority and the outcome was subsequently documented. Particular attention was made to the four top problems and specific needs and solutions were identified.

Farming systems, technologies and species

39. The issue on farming systems and technologies was seen by the experts as very important for the future expansion of the sector. It was noted that, due to the geographical differences of the region, each country may require different systems. In the case of Egypt, the expert raised the restraints posed by limited availability of land and freshwater, poor tidal fluctuations and the shallow coastal waters. The intensification of aquaculture farming systems including the adoption of recirculating systems was seen as a way forward. Some countries (e.g. Morocco, Oman) indicated the need to develop suitable off shore cage culture systems due to the limited availability of protected inshore sites.

40. The need to support investments into hatcheries was also seen as a priority in order to face shortages in the availability of commercial finfish as well as bivalve seeds.

41. The workshop experts agreed that a number of measures are needed to ensure the growth of the sector. These included: (i) the identification and adoption of suitable rearing systems and technologies; (ii) the need for more hatcheries, particularly in certain countries, to ensure the supply of stocking material; (iii) support applied aquaculture research focused on adapting production technologies, and (iv) increase training opportunities for both the public and private sector.

Health and disease

42. A variety of diseases, principally those caused by parasites, fungi and bacteria, affect finfish aquaculture in the region, causing annual losses of up to 10 percent. The main disease problem in crustaceans is viral disease in shrimp. Diseases impact aquaculture in many ways, including sub-clinical infections, and morbidity and mortality that may be acute or chronic. However, mass mortalities due to infectious diseases have been rare. In the region, one main problem identified was the likely transfer of diseases between countries with the movement of fish and shellfish stock. This would threaten disease containment and limit opportunities to export and import.

43. Presently, in some countries, there is poor and inadequate knowledge of infections, thus effective control measures cannot be implemented. Effective disease monitoring programmes are present only in few countries whilst in others these are either ineffective or non-existent. Of particular concern was inadequate, or absent, viral disease diagnostic capability. Some countries in the region send diagnostic specimens to Europe and North America for testing.

44. The priority needs identified by the experts included: (i) the establishment of adequate and functional national and regional harmonized monitoring programmes (some countries reported adequate monitoring programmes); (ii) access to relevant training activities and knowledge to build up national expertise; (iii) improve and strengthen extension programmes; (iv) ensure proper and transparent national reporting; (v) adoption of regional quarantine protocol (Morocco for example has adopted the European directive for live and processed fish movements), and (vi) increase regional collaboration and cooperation in all matters related to fish and shellfish health activities, including establishment of regional centres of expertise. Furthermore, the experts also raised other aspects of disease that may require future consideration, which included potential diseases transmittal from fish to humans, health hazards to which farm personnel are exposed, and safety of the fish and shellfish products particularly with regards to drug residuals

45. The experts generally identified the need for the countries in the region to further increase the implementation of proper developmental actions as indicated in the FAO Code of Conduct for Responsible Fisheries (CCRF).

Policies, legal framework and institutions

46. The experts all agreed that adequate policies are required to ensure a consistent and continuous development process of aquaculture in the region. The absence or ambiguous policies may seriously hinder the sector. Conflict amongst different government institutions, conflict with other sectors, including capture fishery, irrigation, marine transport, tourism and environment, and contradictory laws and regulations were raised and discussed. Coordination of national policies within the region was seen as a pressing need for regional development of the industry.

47. Within the legal and institutional issues, the experts recognized the importance of better coordination amongst the various national institutions engaged and sponsoring the development of the sector. A common understanding of the sectors' needs, and identification and agreement of the priorities, should ensure better collaboration between the agencies involved. It was further emphasised that there was a need to harmonize laws and legislations specific to aquaculture, and to avoid conflicts with other users of such resources (e.g. water rights). Membership of relevant regional bodies and participation in regional/global programmes were also considered important issues which, at the regional level, would ensure the harmonization of some aspects of the sector.

48. Among the solutions discussed by the experts, it was generally felt that the region needed to: (i) increase meetings between sponsoring institutions, and between institutions and beneficiaries; (ii) disseminate regularly information regarding the sector; (iii) ensure that comprehensive national aquaculture development plans are prepared, and (iv) amend and/or harmonize contradicting laws.

Marketing and processing

49. The importance of proper marketing of aquaculture products within individual countries, as well as for export within the region and internationally, was highlighted as an important factor that is likely to influence the future development and growth of the aquaculture sector.

50. The interest in high value species, particularly marine species, continues to attract the attention and interest of the private sector. However, the current low farm outputs result in higher production unit costs than those achieved in neighbouring countries, particularly in the northern Mediterranean basin where the industry is better established for certain commonly farmed species (e.g. European seabass). Access to export markets is consequently inhibited due to uncompetitive prices.

51. It was noted that although individual fish consumption has been increasing as a whole over the past decade, there was a strong need to promote local fish consumption particularly by inhabitants with traditional diets containing little or no fish. Strengthening of internal fish markets and demands were recognized as important issues for the aquaculture industry to grow, particularly in certain countries of the region.

52. Diversification of farmed aquatic species and production of low cost fish were also seen as priorities, particularly in view of the fact that some current farming practices place into the market large quantities of a single species over a concentrated period of few months. Better distribution of such produce could be through processing into value-added products with longer shelf-life compared to fresh fish, and encouraging exports of surplus fish.

53. The priority issues identified by the experts included: (i) the need to increase local fish demand through local marketing networks, generic advertising programmes, product development, accessibility to remote areas and marketing plans; (ii) promote or facilitate investments in fish processing facilities (at least in some countries) to deal with seasonal fish surplus and product

development; (iii) promotion intraregional trade by strengthening existing trade networks; (iv) importance in traceability and labelling schemes to meet international quality standards, and (v) engage active participation of producers association and relevant NGOs particularly in raising awareness of the nutritional qualities of fish and fish products.

54. The issue of national subsidies was also raised by experts who felt that a variety of models should be considered at the national level to, most particularly, encourage the establishment of small-scale enterprises ensuring income in rural communities, and for the production of fish for local promotion and consumption at reasonable market prices. A subsidy programme and adequate investment regulations were also seen as necessary tools, at least for certain countries, for enterprises to establish aquaculture projects. The experts, however, indicated the importance and need for the industry to reduce production cost without the support of incentives and to channel into the markets products which are competitive. This would contribute to the sustainability of the sector.

Socio-economics

55. The discussions of the previous four priorities indicated that the socio-economic dimension of aquaculture is a cross-cutting issue. Aquaculture as a technical economic activity requires skilled workers and cumulative experience to properly establish production units and use of farming technologies. The introduction of aquaculture activities may have an effect on the structure and attitudes of the society where the industry is developing by providing jobs and income generating opportunities. Diets and food consumption traditions may also be affected. Ensuring public awareness of the importance of this sector was considered essential for the sector to develop.

VI. ADOPTION OF THE REPORT

56. Both the revised regional review and the workshop report were subsequently adopted by the workshop participants by e-mail.

APPENDIX A**Agenda**

1. Opening, introductory remarks and adoption of the agenda
2. Presentation of country reviews
3. Presentation and comments of the draft regional review and synthesis document
4. Identification of priority issues and discussion
5. Summary statements and conclusions from priority issue discussions
6. Drafting of the workshop conclusions and recommendations
7. Review and adoption of recommendations
8. Adoption of the report

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APPENDIX C**Priority issue questionnaire**

COUNTRY NAME: _____

The secretariat is assembling topics for discussion as priority issues at the workshop. The experts are invited to complete and return the present questionnaire:

1. Six topics are suggested, please indicate which are the most important from your country's perspective (1 = most important; 6 = least important)
 - a) farming systems, species and technologies;
 - b) health, diseases and environments;
 - c) policies, institutions and legal framework;
 - d) socio-economics;
 - e) information, research and networking;
 - f) processing and marketing.

2. For each of the six topics above, indicate which particular aspects you wish to discuss.

3. Which other topics do you wish to place on the agenda as priority issues for discussion?

4. Information you would like the secretariat to know in advance?

5. Request for information regarding fish and shellfish health.

At the workshop disease control will be discussed as a priority item, please bring information on:

- i. overview of disease diagnostic and monitoring facilities and programs;
- ii. national reporting schemes particularly for "notifiable" diseases;
- iii. certification of eggs, fingerlings, etc., for export;
- iv. quarantine protocols for imported live fish;
- v. other pertinent information.

PART III

COUNTRY SUMMARIES¹

ALGERIA

by

Nadia Moussi

Ministère de la pêche et des ressources halieutiques

Aquaculture in Algeria may be considered as an infant activity from a production point of view. Since the 1920s the sector has gone through four phases: (i) a trial phase in reproducing freshwater fish (*Onchorhynchus mykiss* and *Micropterus salmoides*) and the caramote shrimp (*Penaeus kerathurus*); (ii) a phase related to the experimental culture of molluscs (*Mytilus galloprovincialis* and *Crassostrea gigas*), marine finfish (*Dicentrarchus labrax* and *Sparus aurata*) mullets and eels (*Mugil cephalus* and *Anguilla anguilla*); (iii) development of finfish culture for stocking dams and enhancing inland fisheries using a variety of carp species and pike-perch (*Stizostedion lucioperca*), and (iv) the last phase characterized by the creation of the Ministry of Fisheries and Fisheries Resources in 1999, which supports private operators in establishing commercial fish farms.

The Algerian fish production derives from brackish water areas and freshwater lakes and reservoirs comprising species such as the gilthead seabream, flat-head mullet, European eel (*Anguilla anguilla*), common sole (*Solea vulgaris*), European seabass, white seabream (*Diplodus sargus*), European clam (*Ruditapes decussatus*), Pacific cupped oyster (*Crassostrea gigas*), sand steenbras (*Lithognathus mormyrus*), caramote shrimp (*Penaeus kerathurus*), salema (*Sarpa salpa*), a number of carp species (*Cyprinus carpio*, *Ctenopharyngodon idella*, *Hypophthalmichthys molitrix*, *Aristichthys nobilis*) and barbel (*Barbus barbus*). Shellfish culture, practised by a number of private operators, currently produce around 10 tonnes of mussels and oysters. Farming is carried out on longlines.

The 1999 aquaculture statistics (year of the foundation of the Ministry) showed a production figure of 250 tonnes. This production increased during later years to 351 tonnes in 2000; 454 tonnes in 2001; 476 tonnes in 2002, and 641 tonnes in 2004. In 2003 production dropped due to severe drought (240 tonnes). Approximately 90 percent of the aquaculture production is made up of freshwater fish.

Despite the lack of a tradition aquaculture sector, the Algerian Government is placing emphasis towards programmes focused on commercial fish production. The authority in charge of supporting the development of the sector, has established a National Plan for the Development of Fisheries and Aquaculture Activities covering the period 2003–2007. This five-year plan, organizes activities related to public and private projects. Public projects include demonstration facilities. Private commercial projects have received financial support from the State with subsidies ranging between 40 and 80 percent of the project cost. An additional five projects are expected to be operational by the end of 2006 including two shellfish farms (mussels and oysters), two marine farm (seabream and seabass), have annual capacity of 1 000 and 600 tonnes, respectively. One tilapia farm operates in the south with an annual production capacity of 1 000 tonnes. It runs a hatchery and a processing plant.

The Government of Algeria has established a series of legislative and financial instruments to encourage and enable the development of a sustainable aquaculture industry.

¹ Country summaries made available at the workshop. The full National Aquaculture Sector Overview (NASOs) for each country in the region is available on the FAO Web site.

BAHRAIN

by

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Directorate of Marine Resources

The Kingdom of Bahrain consists of an archipelago of 36 islands covering a total area of 706 km² in the shallow waters of the central Arabian Gulf. Aquaculture/mariculture activities of the Kingdom are mainly carried out by the National Mariculture Centre (NMC) which is under the jurisdiction of the Directorate of Marine Resources (DMR), General Directorate for the Protection of Marine Resources (GDPMR), Public Commission for the Protection of Marine Resources, Environment and Wildlife (PCPMREW).

Commercial mariculture is still in its infancy stage, and has good opportunities for development. Realizing the importance of aquaculture development, the Government established the National Mariculture Centre to carry out the applied scientific research in this field. The National Mariculture Centre was started as a pilot project as a result of cooperation with the Food and Agriculture Organization of the United Nations (FAO) in 1979 at Ras Hayan on the southeastern coast of Bahrain, with the following objectives:

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

The research activities of the Centre include studies on the nutrition, reproduction, hatchery, nursery and growout of rabbitfish (*Siganus canaliculatus*), sobaity bream (*Sparidentex hasta*), mangrove snapper (*Lutjanus argentimaculatus*) and brown-spotted grouper (*Epinephelus coioides*). Major success has been achieved in growth trials of rabbitfish and a variety of seabream species using different culture systems. Growout trials on the grouper and the green tiger shrimp (*Penaeus semisulcatus*) have been studied. Since 1994, stock enhancement trials have started using hatchery-reared groupers, and a number of species of seabream, where releases of about half a million fingerlings were made at more than ten sites in the waters of Bahrain. Nowadays, this stock enhancement programme is one of the regular activities of DMR. Since January 2005, the Kingdom of Bahrain introduced the gilthead seabream (*Sparus aurata*) for the first time for nursery rearing as part of a scheme to boost its mariculture production in the coming years.

The main objective of the Directorate of Marine Resources is to have a judicious start and expansion of industrial mariculture in the Kingdom of Bahrain, in which every aspect of the whole process of mariculture will be considered and meticulously controlled from larval rearing to post-harvest activities. Therefore, the DMR has plans to add new research and culture facilities to the National

Mariculture Centre in order to cope with the expected expansion in this important sector. The rules and regulations that will control this sector are being studied for final approval. A Plan of Action for mariculture development in the Kingdom, formulated by the Directorate of Marine Resources, is continuously revised and discussed among different governmental authorities who have relation with the aquaculture sector.

Currently, the Directorate of Marine Resources consists of a Director (Bahraini), 11 professional and technical staff and 9 supporting staff (all Bahrainis), with an additional 11 staff from a private company within a cooperation agreement. The majority of the staff is involved in mariculture activities. At present, there are no commercial aquaculture farms in the Kingdom of Bahrain, except the culture facilities and equipments at the National Mariculture Centre, which is involved in applied mariculture research leading to the establishment of commercial mariculture projects. The NMC is also extending its expertise in the area of mariculture, i.e. marine finfish hatchery technology and cage culture of marine finfish, including the sobaity seabream and rabbitfish to private companies. The Kingdom has now emerged as a leader in the marine finfish hatchery technology and as a major finfish seed supplier in the region.

According to 2005 estimates, Bahrain's population amounted to 688 345 persons of whom 385 473 were male (56 percent) and 302 872 female (44 percent). The proportion of non-Bahrainis accounted for 34.7 percent, of whom 71 percent were male and 29 percent female. The per capita fish consumption in Bahrain was 17.6 kg in 1990 which declined to 16.7 kg in 2003. This decrease in fish consumption may be linked to the increase in fish exports (416 percent) and a 37 percent in the population of Bahrain within the last 14 years.

The geographic area of the country and lack of free coastal lands, indicate that floating cage culture and recirculation aquaculture systems are the most promising farming systems. Efforts are underway to promote such systems and encourage private sector investments through pilot demonstration projects and consultation services. The little production that comes from the NMC mariculture facilities is marketed locally. Current production amounts to a moderate 12 tonnes/year of mainly two commercially important local marine finfish, the sobaity seabream and rabbitfish. The average wholesale price for cultured sobaity seabream and rabbitfish range from US\$2.66 to 4.0/kg. There is little difference in price between wild and cultured fish. In 2005 Bahrain exported about 272 000 sobaity seabream juveniles and 1.9 million European seabream fry to neighbouring countries. Contribution of fisheries and aquaculture to GDP was approximately BHD9.2 million in 2003 which is equal to 0.7 percent sector share to GDP composition of the Kingdom of Bahrain in 2003.

The Royal Decree on Exploitation and Utilization of Marine Resources, issued in 2002, has provisions for controlling aquaculture activities of cultured organisms in different aspects such as licensing, technical requirements and quality issues. According to the law, a company cannot start an aquaculture project without permission from the authorized government body (Directorate of Marine Resources). It also controls the catch of seed from the wild. The Government realized the importance of the regulations and rules for sustainable development of aquaculture. Unregulated and uncontrolled aquaculture sector will lead to many environmental, economical and social problems. All aquaculture rules and regulations are set out in one framework that is transparent, enforceable and complements other laws and regulations of the Kingdom and international laws. Aquaculture laws and regulations of the Kingdom are currently being revised and updated within a regional cooperation committee under the umbrella of FAO Regional Commission for Fisheries (RECOFI).

More aquaculture research is needed for a better management of this growing sector. The main areas of research that should be focused on are the following: (i) identifying the most suitable local and exotic species for aquaculture; (ii) environment monitoring programmes; (iii) fish health and disease control and (iv) enhancing the legal and administrative framework. In the long run, investment in the use of this renewable resource will contribute to food security and self-sufficiency of the Kingdom, provide job opportunities and diversification of income for local fishermen, and help to increase national income through the export of aquatic products.

EGYPT

by

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General Authority for Fish Resources Development (GAFRD)

Aquaculture is presently the largest single source of fish in Egypt. The production of this activity is the fastest and strongest growing sector in the field of fisheries in the country. It is also considered as the only available option for covering or reducing the gap between production and consumption of fish in Egypt. Total aquaculture production of Egypt was estimated at 445 100 tonnes in 2003 with a total local market value equal to US\$584 662 million (1 US\$ = 5.78 EGP). This activity represents about 51 percent of the 876 000 tonnes of fish produced in the country and about 43 percent of the total fish consumed (1.04 million tonnes). The current annual fish consumption is approximately around 15.2 kg/person. At present almost the entire aquaculture production derives from privately-owned farms.

Aquaculture in Egypt has been known since the beginning of written history. The traditional form of aquaculture “Hosha” practiced for more than 500 years was common until a few decades ago in the northern Nile delta lakes. Modern aquaculture started in the mid-1930s following the introduction of the common carp (*Cyprinus carpio*). The first commercial farm was built by the Government in 1961.

Modern aquaculture expansion started in Egypt only two decades ago. Aquaculture production jumped from a humble 17 000 tonnes in the late 1970s to 45 000 tonnes in the mid-1980s. Production increased steadily during the late 1980s and early 1990s. In 1986 aquaculture production was 51 000 tonnes, increasing in 1990 to 60 000 tonnes and in 1995 to 72 000 tonnes. The sector further witnessed a fast development during the last decade with a sharp increase in production. Total aquaculture production jumped from 340 000 tonnes in 2000 to almost 500 000 tonnes (2004–2005 estimates). The current development in production is associated with the application of higher levels of technology which resulted in a change of the fish farming community structure. The high rate of return on investment in aquaculture has attracted a large number of small to middle sized investors. Those with higher scientific backgrounds invested in production systems with high return. The industry is further becoming more sophisticated and diverse as it is also associated with a growing supportive sector such as feed mills and hatcheries. The number of hatcheries has increased from 14 in 1998 to over the current 230. Over 12 fish feed companies have been established in the last decade.

Except for very limited and isolated cases, most aquaculture activities are located in the Nile Delta Region. The majority of fish farms in Egypt can be classified as semi-intensive brackish water pond farms. During the early 1990s these farms were vulnerable to dramatic reduction in number and area, due to land and water competition with other economic sectors and land reclamation for agriculture. Intensive culture in earthen ponds and tanks is now expanding rapidly. Intensive pond aquaculture was introduced in the mid-1990s substituting semi-intensive and traditional farms. The activity is expanding as a result of high returns on investment and is likely to become the major aquaculture system in the country. The system depends on smaller, deeper ponds, high stocking densities, intensive feeding and aeration with an average production of 17.5–30 tonnes per hectare per year. Integrated desert agriculture-aquaculture started in Egypt in the late 1990s. This activity is expanding in the western desert and uses intensive tank aquaculture.

Presently, the majority of cultured fish are either freshwater species or those that can grow in brackishwater. The production of fish and crustaceans in seawater is still in its early stages and its development suffers from technical and economical problems. Aquaculture of marine species (e.g. seabass, seabream, sole, meagre and penaeid shrimp) started in the late 1980s and early 1990s. Except for shrimp, the majority of the cultured marine fish depends on seed collected from the wild. Marine aquaculture in Egypt is still far from being as successful as freshwater farms.

Presently, 16 different species of fish and crustaceans (14 finfish and 2 crustaceans) are cultured in Egypt. Ten out of the 16 species are native and six introduced. The native species are: Nile tilapia (*Oreochromis niloticus*) (48 percent of aquaculture harvest in 2003), blue tilapia (*Oreochromis aureus*), African catfish (*Clarias gariepinus*), grey mullet (*Mugil cephalus*), thin-lipped grey mullet (*Liza ramada*) (both species together contributed to about 30 percent of aquaculture harvest in 2003), bluespot mullet (*Valamugil seheli*), European seabass (*Dicentrarchus labrax*), gilthead seabream (*Sparus aurata*), meagre (*Argyrosomus regius*) and penaeid shrimp. The introduced species are: common carp (*Cyprinus carpio*), grass carp (*Ctenopharyngodon idella*), silver carp (*Hypophthalmichthys molitrix*), bighead carp (*Aristichthys nobilis*), black carp (*Mylopharyngodon piceus*) and the giant freshwater prawn (*Macrobrachium rosenbergii*).

Although there are no accurate statistics on the number of people involved in aquaculture and its associated activities, it is estimated that about 63 000 persons are directly involved in the activity. Employees have different levels of skills and education, varying from elementary education to highly trained post graduates.

Aquaculture is considered as the only possible solution to increase fish production in Egypt. In its strategic development plan, the Ministry of Agriculture and Land Reclamation plans to increase the country's fish production to 1.5 million tonnes by 2017, and is targeting a harvest of 1 million tonnes from aquaculture. The sector, so far, is growing at levels exceeding those targeted in the plan.

IRAQ

by

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Ministry of Agriculture

Iraq has rich and varied water resources (rivers, lakes, dams, etc.) suitable for enhancing its fishery resources especially in inland waters. Such resources have not been sufficiently and adequately exploited during the last decade. Total fishery production increased from 335 000 tonnes in 1994 to 353 000 tonnes in 2001. This increase was mainly for the marine sector as the production of freshwater fish declined considerably. Annual fish consumption in Iraq decreased from 2.8 kg/person in 1979 to less than 1.4 kg/person in 2000.

By the end of the 1990s the number of fish farms in the country was over 1 600 with a total utilized water surface area of about 60 000 hectares. However, in 2003, only 534 farms were in operation. The current production of the farms is low compared to their potential capacity, mainly due to inadequate management and increased production costs. Many farms also experienced virus diseases, previously unknown to Iraq, which caused extensive fish mortalities. In Iraq there is currently only one type of fish pond rearing system, i.e. intensive closed system using concentrated zooplankton for the culture of common, grass and silver carps. All existing farms belong to the private sector.

In 2003 there were 25 hatcheries in Iraq which produced fry and fingerlings of different carp species, which were sold to family run fish farms. In recent years, the number of hatcheries has increased in order to satisfy the local demand of fingerlings although there are inadequate regulations to ensure the quality of the fish produced.

During the 1970s the Government ensured that technical farming skills were acquired by sending local experts for training abroad to specialize in management of fish resources and aquaculture. At the same time, the General Company of Fishing and Fish Marketing was established to assist with the development of the sector by encouraging the creation of fish farms, hatcheries and cooperatives.

Given the absence since 1990 of an institutional framework, the sector has experienced a decline in the quality and quantity of fish produced. The lack of proper technologies in all aspects of the sector (production through to processing), poor research activities, and the absence of an adequate state policy have all contributed to the poor development of the industry. The only applied research on fish culture has been undertaken by the Zaafarania Centre. The aquaculture industry has nevertheless great potential, considering the availability of water resources and improved farming techniques.

The current situation is characterized by the wild and uncontrolled exploitation of fisheries resources. There is a need for a strong institutional policy and legal framework to support the development of this sector, particularly to encourage private investment.

LEBANON

by

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Aquaculture begun in Lebanon in the 1930s, and today more than 90 percent of aquaculture production in Lebanon is rainbow trout (*Onchorhynchus mykiss*). There are approximately 150 farms or holdings using semi-intensive growing systems. The annual production of trout is approximately 600 tonnes (from 150 farms; 80 percent of which are in Hermel-North Bekaa) with a total value of US\$2 million, and the estimated average yield being 10–12 tonnes (approx. 1.5 kg/l/min).

Marine aquaculture is not widely practiced in Lebanon. There is, however, one shrimp farm initiated by a private investor in the northern part of the country. Furthermore, a number of feasibility studies for rearing the European seabass (*Dicentrarchus labrax*) and gilthead seabream (*Sparus aurata*) in floating net cages have been carried out.

Lebanon has an estimated 3 000 to 4 000 fishermen with an annual fish production (capture and aquaculture) totalling 4 485 tonnes in 1996, of which 4 110 tonnes are marine fish and 375 tonnes are freshwater fish (mostly from aquaculture). There is no breeding of marine finfish along the coast (coastal currents are strong in most places). Offshore fishing of pelagic fish (e.g. bluefin tuna) has increased during the past decade, mostly amongst recreational fishermen.

Most trout farms are semi-intensive and usually family-owned businesses. Shifting to commercial farming is unlikely to happen in the near future mainly due to the inadequate marketing system. However, a number of large-scale, private, joint-venture, commercial projects are under evaluation, particularly in bluefin tuna farming. At present all commercial feeds are imported mainly from Italy, Denmark, Chile and other South America countries. Farming of the rainbow trout is an income generating activity. Farms also operate small restaurants in popular recreational sites. Restaurants (about 60) usually serve 250–350 gram trout at a cost of US\$10 per kilogram although most Lebanese still prefer marine fish. The demand for trout is nevertheless growing. Value added trout products are still not available in the local market. Small quantities of trout are sold through supermarkets.

Compared to other Mediterranean countries, Lebanese fish annual consumption is still low at around 4 kilograms per person. According to official data provided by the Lebanese custom authority, Lebanon imported in 2004 about 16 500 tonnes of fish and mollusc products (at US\$40 million), compared to about 158 500 tonnes (at US\$229 million) of red meat. Imports of live, fresh or frozen fish (including crustaceans and molluscs) amounted to 14 000 tonnes (US\$35.6 million), dominating canned and fish products (including caviar and caviar substitutes) imports of around 1 608 tonnes valued at US\$4.6 million.

Fish import is mainly from Turkey (17 percent of total import), followed by Egypt (9 percent), Argentina (7 percent), United Kingdom (7 percent), India (6 percent) and the Sultanate of Oman (5 percent). The main markets for Lebanese crustaceans and molluscs (valued at US\$0.5 million) are the Syrian Arab Republic and Jordan, whereas prepared products are mainly destined to Burkina Faso, Gabon, Nigeria, Zaire and other Central African countries.

The lead government agency for aquaculture development is the Ministry of Agriculture. Licensing for fishing is vested within the Directorate of Rural Development and Natural Resources. This is done through the Anjar Centre for Aquaculture located in Bekaa, the Institute of Oceanography and Fisheries, and the Chouaifat Aquaculture Centre. The National Centre for Marine Research (NCMR) under the National Council for Scientific Research (NCRS) is responsible for marine aquaculture research, and is the only public research institution in the country. In addition, there are several private

research institutions and universities (e.g. the American University of Beirut, Balamand University) and the Lebanese National University.

The aquaculture sector in Lebanon, though not yet fully developed, has good potential considering the availability of resources and favourable growing conditions. The farming practices and technologies used need to be improved. Further research is also needed to improve feed conversion and to ensure proper health management. Adequate legislation related to aquaculture production, including environmental protection, certification and labelling, needs to be developed and enforced. Furthermore, accurate statistics are required to ensure a proper and strategic developmental planning of the sector. Lack of funds and human resources are two factors contributing to such gaps.

LIBYAN ARAB JAMAHIRIYA

by

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Marine Biology Research Centre (MBRC)

Aquaculture is a recent activity in Libya which started by culturing different species of freshwater fish. A variety of carp species and tilapia were introduced during the 1970s and 1990s, respectively. Catfish and carp (common carp, grass carp, bighead carp and silver carp) were imported from China PR and were cultured semi-intensively in artificial dams and water reservoirs. Nile tilapia and red tilapia imported from Egypt spread rapidly throughout the country.

Marine fish culture was started in the 1990s by the Government; fingerling of the European seabass (*Dicentrarchus labrax*), gilthead seabream (*Sparus aurata*) and mullet spp. were collected from the wild and reared in small cages in lagoons. The overall production was limited to 30–40 tonnes over ten years. In recent years (2000–2003) a number of private investors emerged with technical assistance provided by the Marine Biology Research Centre (MBRC). Loans have been made available by the State along with imported fingerlings of seabass and seabream. In 2004 mariculture output of the latter two finfish species and Atlantic bluefin tuna (*Thunnus thynnus thynnus*) amounted to 391 tonnes. Atlantic bluefin tuna fattening was first introduced by the private sector in 2003.

Both intensive and extensive aquaculture systems are applied using floating marine net cages, concrete and earth ponds. Due to the poor availability of suitably protected sites along the Libyan coast, inshore cages (22 m in diameter) are used off the east coast, while offshore cages are used off the western coast. To date there is no local market for mariculture products which are therefore exported. Freshwater fishes are reared using extensive systems in dams, small lakes and irrigation ponds. Tilapia is a favoured fish and widely cultured throughout the country. Most of the seawater used on land-based farms is extracted from underground. It is estimated that approximately 140 persons are currently employed in the aquaculture sector including hatchery technicians and labourers. In 1997 it was estimated that annual fish consumption was around 6.5 kg/person.

The Marine Biology Research Centre (MBRC) located in Tajura is the main institution providing assistance in the field of aquaculture. The centre employs 52 researchers and qualified technicians. In 2001 a smaller branch of the centre was established in Benghazi, the second largest city in the country. The centre has also been supplying fertilized eggs of gilthead seabream as well as a local strain of rotifers to a large hatchery complex established in 2004 by the National Marine Investment Institute.

In terms of higher education in aquaculture, the Faculty of Agriculture at the Alfateh University in Tripoli has offered, since 1996, a Bachelor of Science in Aquaculture Sciences.

Although the development of mariculture is slow and production still limited, the sector has good developmental potential. The current policy of the Government is to support the growth of the sector particularly by granting loans, land, and providing subsidies particularly for the purchase of farm equipment and other inputs. Plans exist for establishing a fish feed plant.

MOROCCO

by

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Aquaculture begun in Morocco in the 1950s with a small number of oyster farms based on the Atlantic Ocean (Oualidia Lagoon). During the period 1994 to 1999 the total production increased from 1 463 tonnes to 2 798 tonnes, and then subsequently decreased, in 2003 being only 1 538 tonnes, and in 2004 some 1 698 tonnes. This production represents only 0.19 percent of the total fisheries production which has an annual turnover of 1 million tonnes. Although Morocco has a rich fisheries resource it does not favour the development of the aquaculture sector which remains a marginal activity within the fisheries sector.

In 2004, marine fishes represented 47 percent of the total aquaculture output with a production of 788 tonnes, followed by freshwater fishes which represented 40 percent with a production of 685 tonnes, and molluscs with 200 tonnes (13 percent). Marine aquaculture is based mainly on gilthead seabream (*Sparus aurata*) and European seabass (*Dicentrarchus labrax*) which accounted for 91 percent of the total production of cultured finfish in 1994. This activity began in 1987, since then finfish culture has stagnated and further declined after the closure of two aquaculture companies due to the drop of prices in the EU market.

Currently, only two companies, producing mainly finfish, are operational on the Mediterranean coast. The majority of the production is for export to EU markets (Italy, Spain and France). The production of freshwater aquaculture is dominated by carp which accounted for 88 percent of the freshwater fish production. Most of the production is used for stocking reservoirs. There are companies which produce fingerlings and deliver them to the national authority for drinking water. Rainbow trout, *Oncorhynchus mykiss*, production declined from 100 tonnes in 1994 to 50 tonnes in 2004. Compared to 1999 outputs, the production of common carp (*Cyprinus carpio*), Chinese carp (*Ctenopharyngodon idella*), and silver carp (*Hypophthalmichthys molitrix*) decreased by 43 percent in 2004.

In order to promote the freshwater aquaculture, other species were introduced such as black-bass (*Micropterus salmoides*), northern pike (*Esox lucius*), pike-perch (*Stizostedion lucioperca*) and more recently the Nile tilapia (*Oreochromis niloticus*) from Egypt (2004). With regards to the production of European eel (*Anguilla anguilla*), grass eels are collected in several Moroccan estuaries. Their production decreased from 1994, where the production was 85 tonnes, to a 2003 amount of 64 tonnes, as the culture of this species relies entirely on wild grass eels whose availability depends on the weather conditions. The increased pollution in local estuaries has also impacted this sub-sector.

Shellfish culture is the oldest aquaculture practice in Morocco. Since its commencement the production has remained constant at about 200 tonnes per year. In 2004, six companies produced a total production of 160 tonnes; mainly the Pacific cupped oysters (*Crassostrea gigas*). It is expected that this production will increase significantly as several projects are operational and produce mussels, clams and oysters in the Dakhla Bay. In the region of Agadir some trials are in progress using new rearing technologies.

There are several interesting species that have previously been cultured, but eventually abandoned for different reasons (predation, disease, scarcity of juveniles, etc.) during the last 20 years. The most important species are the Atlantic bluefin tuna (*Thunnus thynnus thynnus*); the kuruma shrimp (*Penaeus japonicus*); the European clams (*Ruditapes decussatus*); and the yesso scallop (*Patinopecten yessoensis*).

In marine finfish culture, the only rearing system practiced is the intensive system. Holding facilities vary from land-based culture to sea cages (sea between 20–30 m, protected area, lagoons or estuaries). Seabass and seabream are both reared in floating cages placed either in lagoons or protected areas of the sea. Land-based systems are used only for freshwater fish such as rainbow trout and carp. The culture of shellfish is still very traditional and the culture system is dominated by suspended bags on iron racks located in the intertidal zone. More recently some commercial trials have been undertaken using longlines in the Atlantic.

Although Morocco is one of the most important countries with regards to the production of fish meal, its production value being 75 000 tonnes per year, an aquafeed industry does not exist. It is also worth noting that feed represents a major handicap for making national aquaculture products competitive on the international market, as at present, all the feed used is imported. In fact, feed makes up about 15–30 percent of the total production cost, depending on the species cultured and feed selected. Currently, fish feed is imported from Europe, mainly from Spain.

There are several obstacles which constitute a handicap for the development of the aquaculture sector and the emergence of an aquaculture industry, which is economically profitable and biologically sustainable. In this regard, in 2003 the Government of Morocco organized the first day of aquaculture which was attended by the operators of the sector. Its scope was to establish a legal framework in favour of the development of this sector, capacity building, establishment of measures for promoting investment, and to discuss applied research and technology needs in aquaculture.

Morocco has a coastal line of 3 500 kilometres and rich coastal resources. However, the annual national consumption of fish per person remains low compared to other countries in the region (7.5 kg/per/yr). The contribution of fish to the protein consumed remains low. However, this contribution to the Moroccan diet is expected to increase, partly because of public awareness of the health benefits of eating fish, and the establishment of processing plants and improved transportation.

Through the Department of Marine Fisheries, potential aquaculture development is being studied, along with the identification of a policy for aquaculture development, and the analysis of necessary support measures. Development of the sector could be enhanced by establishing a local fish feed production plant, reducing administrative barriers, providing economic incentives, strengthening sanitary controls for fish and shellfish, developing integrated regional aquaculture plans, diversifying farmed species, training the operators of the sector, and encouraging targeted and applied research in support of commercial aquaculture.

OMAN

by

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General information – The Sultanate of Oman occupies the eastern tip of the Arabian Peninsula. It has a coastline of circa 3 165 kilometres overlooking three seas: the Arabian Gulf, Gulf of Oman and the Arabian Sea.

Gross National Produce (GNP) – The non-oil export value increased from OMR265.8 million (Rial Omani) in 2001 to OMR304.1 million in 2003. The main exporting commodities are livestock, agriculture and mineral products. In the same period, the import value increased also from OMR2 229.1 million in 2001 to OMR2 526.7 million in 2003. This is due to the major development in Oman, which implies continuous increase in the importation of commodities. The total government revenue increased from OMR2 539.8 million in 2001 to OMR3 305.3 million in 2003.

Population growth rate – According to the last census in 2003, the total population of Oman in 2003 was 2.3 million people of which 559 000 were expatriates (almost 24 percent of the total population).

Fish consumption – As large portions of the population in Oman live near the coast, fish as a source of animal protein is in high demanded. Recent data from the Food and Agriculture Organization (FAO) indicates that fish consumption in Oman is approximately 26 kg/per/yr which is the highest among the Near East countries.

Aquaculture production – Commercial aquaculture production in Oman began in 2003 and the total production was 352 tonnes which increased to 515.6 tonnes in 2004. The cultured species are outlined in the table below. The first three species were introduced species.

Aquaculture production (tonnes) during 2003 and 2004.

Species	Scientific name	2003	2004
European seabream	<i>Sparus aurata</i>	331	460
Seabass	<i>Dicentrarchus labrax</i>	13	27
Mullet	<i>Acanthopagrus latus</i>	8	-
Yellowfin seabream	<i>Epinephelus coioides</i>	-	13
Yellowfin tuna	<i>Mugil spp.</i>	-	14
Spiny-cheek grouper	<i>Thunnus albacres</i>	-	0.222
Nile tilapia	<i>Oreochromis niloticus</i>	-	1.4
Total		352	515.6

Market – The majority of aquaculture production in Oman during 2003 and 2004 was exported to the United Arab Emirates (UAE). A very minor quantity was targeted for the domestic market, while the production from the tuna fattening project was exported entirely to Japan.

Aquaculture systems – In Oman, cage culture is the main culture system. Small cement ponds were used in different small-integrated aquaculture systems for tilapia.

Commercial aquafeed – Currently, there is no commercial production for aquafeed in Oman. The existing aquaculture company for finfish cage culture imports the feed from Saudi Arabia. From 2001 to 2004, the total quantity of imported aquafeed was around 1 900 tonnes.

Human resources in aquaculture – Currently, the number of people involved in aquaculture in the Ministry of Agriculture and Fisheries is nine (eight Omani and one non-Omani expert). In the private sector, 26 technical persons are employed of which 16 are Omani.

The institutional framework – The General Directorate of Fisheries under the Ministry of Agriculture and Fisheries is the leading government agency for aquaculture development in the country. Under this Directorate, there are different sections that are responsible for aquaculture management which include an aquaculture laboratory and a fish quality control centre.

Trends for aquaculture – Aquaculture in Oman has good opportunities for expansion and the number of applications from the private sector is increasing. The Government plans to build new aquaculture centres to cope with the expected expansion in aquaculture and to carry out the targeted research. Furthermore, the Government issued a series of new regulations to ensure that the sector is developed and managed in a sustainable manner. There are numerous environmental rules which can be applicable to aquaculture, ensuring that aquaculture projects are safe for the environment.

The Ministry of Agriculture and Fisheries will establish two fisheries training institutes for graduate students which will cover aquaculture activities. The major problem in aquaculture is land allocation and competition with other commercial sectors (e.g. tourism).

SYRIAN ARAB REPUBLIC

by

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It was 1200 years B.C. when aquaculture became known in ancient Syria. The Phoenicians, the famed textile dyers, used to fish the *Murex* sp. and keep it in small holes with seawater in order to extract the purple pigment. A few centuries B.C. freshwater fish farming was believed to be practiced in the Euphrates valley following annual flooding. Fish were trapped, fed and then harvested. Modern aquaculture in the Syrian Arab Republic dates back only to the late 1950s.

Production, cultured species and systems

Syrian aquaculture is today exclusively practiced in freshwaters, and is restricted to finfish and more specifically, to warm freshwater finfish culture. Its annual production increased during the 1990s from 3 253 tonnes to 6 797 tonnes by 2000 and 8 682 tonnes by 2004, with an estimated value of the latter being SYP600 million (Syrian Pounds), the equivalent of US\$12 million.

Commercial aquaculture has, so far, been limited to two fish groups: carps and tilapias. The culture of common carp (*Cyprinus carpio*) contributes primarily to aquaculture production (4 245 tonnes). Grass carp (*Ctenopharyngodon idella*) and silver carp (*Hypophthalmichthys molitrix*) have recently been introduced as secondary species. Tilapias, which are believed to be a mixture and random hybrids of *Oreochromis aureus* and *Oreochromis niloticus*, rank second in production (3 650 tonnes). African catfish (*Clarias gariepinus*), the culture of which is confined to the few warm springs in the Al-Ghab region, remains a minor component (747 tonnes in 2004).

In production practices, pond culture predominates (81 percent), while cage culture in large reservoirs, and culture-based fishery in small barrages, also contribute to aquaculture tonnage by 12 percent and 7 percent, respectively (2004). These proportions can, more or less, reflect the production values thereof. Pond fish farmers prepare the pond sediment to improve primary production and use either monoculture of tilapia or polyculture of African catfish and tilapia or complementary species of carp. With the exception of the few governmental fish farms that use pelleted fodder, private fish farms depend on barley, wheat bran, cotton seed cake and different inedible cereals. Also abattoir by-products illegally find their way to private fish ponds. Cage culture is carried out solely with common carp being fed with pelleted feed. Productivity of barrage lakes is sometimes enhanced by using a variety of by-products from the food industry as well as inedible cereals. Aquaculture productivity accordingly varies from 300–800 kg/ha/year in barrages, to 4–16 tonnes/ha for carp and/or tilapia and 10–35 tonnes/ha for African catfish per season of seven months in earth ponds, up to 20–35 kg/m³ in cages over the same period of time.

Except for cage culture of common carp in medium- to large-size cage systems (cage capacity ranging from 35 or 300 m³), aquaculture activities are mostly small-scale, with the majority of fish farms being comparatively small (1–5 ha). Work on these farms nevertheless provides relatively good living standards in comparison with other agricultural activities.

Feeds

The domestic production of pelleted feeds, which amounted to 5 000 tonnes in 2004, has been entirely used in government-owned fish farms that yield approximately one fifth of national aquaculture production. In an effort to minimize the use of raw abattoir by-products, the Ministry of Agriculture has recently instructed its General Establishment for Fodder to attempt to cover the needs of all private fish farms. Some newly constructed fodder plants are considering the production of fish feeds.

Human resources and institutional capacity

The educational level of pioneer aquaculturists was elementary, while newcomers are technically prepared with some operators holding a university degree. As to gender distribution, women are not heavily engaged in aquaculture except in small-scale operations where a single pond is managed by the one family without the employment of external labour.

Administratively, all aquaculture activities are under the responsibility of the Department of Fisheries Resources (DOF) in the Ministry of Agriculture. The DOF drafts and updates relevant legislation, sets regulations and collects relevant statistical data. Some of the additional obligations of the DOF include testing new techniques, introducing new fish species, supplying aquaculturists with fingerlings, and commenting on the feasibility of technical investment projects. With its 15 field services, 64 university staff, and 150 high school and technical school graduates, the DOF regularly issues licences, grants culture-based fishery rights, supplies extension services and monitors aquaculture activities.

In the late 1970s, courses on aquaculture were included in the curriculum of the Faculty of Agricultural Sciences in Damascus University. Later on, aquaculture was included in other Syrian universities, high schools, and technical, agricultural and veterinary schools. However, applied aquaculture research has not yet been undertaken by universities and research centres as they are still restricted to the work carried out by the DOF. In light of this, applied research, field diseases survey and skill upgrading of extension officers, remain pressing needs if the sector is to develop and expand.

Currently about 950 private operators and over 1 350 labourers are estimated to be engaged in aquaculture on a full-time employment basis. Seasonal activities provide employment opportunities on a part-time basis to some 1 800 labourers. Fish farming directly sustains over 4 000 families or approximately 25 000 people on a full or part-time employment basis.

Population, fish consumption and GDP

The population of Syria in 2003 was estimated at 17.55 million. The annual growth rate has declined markedly over the last three decades. Per capita fish consumption is comparatively small, not exceeding 1.77 kg/year, out of which 0.41 kg comes from aquaculture, 0.51 kg from capture fisheries and 0.85 kg from fish imports (2003). For total animal protein consumption, fish contributes 2.8 percent against 20.5 percent for eggs, 24.8 percent for chicken, 34.2 percent for red meats and 17.7 percent for milk and dairy products (2003).

Agriculture has traditionally been the mainstay of the Syrian economy, contributing 25 percent to the GDP, out of which aquaculture contributes a mere 0.25 percent if all the associated industries, services and value-added secondary processes are included.

Markets and exports

No export or import of aquaculture products has been registered in the past decades. National aquaculture products are still confined to the local market, and therefore there is no pressing need for labelling or certification. These concepts are nevertheless under consideration by the private sector.

Trends, weakness, strengths and opportunities

Aquaculture has always been an attractive option for investment, but some extra-sectorial driving forces have been indirectly hampering the establishment of aquaculture enterprises. Allocation of water rights for pond fish culture has been a major issue. Expansion of cage culture and culture-based fishery, particularly in dams and irrigation canals has encountered exaggerated reluctance. It is expected, however, that the negotiations undertaken by the DOF with the water authorities will ease the complexity of allocating water rights.

TUNISIA

by

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The Tunisian coastline is more than 1 300 km long, and the country's land surface of approximately 163 610 km² is inhabited by a population estimated to be around 10 million. The fishery sector is an important economic activity from social and nutritional points of view. The current capture production level has stagnated and therefore it is believed that the local demand for fish and fish products will be met through the development of the marine and freshwater aquaculture sector. The annual fish consumption per person in 2004 was estimated at 9.5 kilograms although the consumption level among the inland inhabitants does not exceed 1.5 kg/person/year.

Aquaculture in Tunisia can be divided in three distinct developmental phases:

1. During 1957 and 1984 a research and trial phase was carried out in order to have the necessary information for the development of this sector;
2. From 1984 and 1995 several research and commercial aquaculture projects were carried out;
3. From 1995 to 2005 focus was on the organization and planning of the sector. A strategy was developed and several projects were initiated, with the aim of achieving a production of 12 000 tonnes by 2013. The current production is estimated at about 3 700 tonnes which represent 3 percent of the total fisheries production with an export value of TND29 million (Tunisian dinar) or US\$21.8 million. Aquaculture production in Tunisia has slightly increased during the recent years.

Aquaculture in Tunisia is mainly based on freshwater finfish culture and contributes towards improving the revenue of the rural population as well as contributes to food security.

In the freshwater fish culture sector, a number of exotic species were introduced in the country such as the pike-perch (*Stizostedion lucioperca*), black bass (*Micropterus salmoides*), and a variety of Chinese carps (grass carp, silver carp, and bighead carp) as well as the Nile tilapia (*Oreochromis niloticus*).

In the marine aquaculture sector the gilthead seabream (*Sparus aurata*) and the European seabass (*Dicentrarchus labrax*) are the main species cultured either in raceways or cages. Mussels and oysters are cultured on bottom racks and submerged longlines, while the Atlantic bluefin tuna (*Thunnus thynnus thynnus*) is reared in large floating cages.

Currently, extensive culture systems are employed in reservoirs. With regards to the exports of fish products, sharp competition was experienced in 2005. In contrast, the local market is currently stable. All fish feed used in Tunisian aquaculture, some 3 500 tonnes/year, is supplied by the European Union (mainly France, Italy and Spain).

Aquaculture is managed directly by the Ministry of Agriculture and Water Resources (Ministere de l'agriculture et ressources halieutiques) and the State Secretary (Secretariat d'Etat) which is in charge of fisheries and aquaculture. A General Directorate of Fisheries and Aquaculture was established to directly manage the sector.

YEMEN

by

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Aquaculture Research Centre (ARC)**

A lack of experience, finance and investment has resulted in the slow growth of the aquaculture sector in Yemen. At present, the Aquaculture Research Centre (ARC) in Aden, established in 1988 with the assistance of the Japan International Cooperation Agency (JICA), and the privately-owned Musallam Farm, established in 2004, are the only two operational aquaculture facilities in the country. Work has recently begun at Al-Shihr, on the eastern coast, for the construction of a new farm utilizing German investment and closed re-circulation technology. Many Yemeni investors are beginning to show interest in the sector and as a result a survey to identify areas suitable for shrimp culture has been conducted in cooperation with the Egyptian National Institute of Marine Science and Fisheries.

The Aquaculture Research Centre is part of the Marine Science and Resources Research Centre, an institution created through co-operation between the Islamic Development Bank (ISDB) and the United Nations Educational, Scientific and Cultural Organization (UNESCO) in 1983. This Centre reports directly to the Ministry of Fish Health. In 2002 the Minister of Fish Health submitted a proposal for a new institutional framework to enhance the activities of the fishery sector; however this has yet to be implemented.

The ARC is located at the western end of the Gulf of Aden, Al-Buraika District (Aden Governorate) and covers an area of about 30 000 m² and utilizes concrete tanks supplied with seawater, covering an area of one hectare. The ARC employs a total of 31 people including 6 researchers, 10 technicians and 15 workers operating a hatchery and a small-scale feed facility. The main species currently being studied as suitable aquaculture candidates are the Indian white shrimp (*Penaeus indicus*), the green tiger shrimp (*Penaeus semisulcatus*) and the goldlined seabream (*Rhabdosargus sarba*). The shrimp are farmed using a semi-intensive production system, with culture density of 15 postlarvae/m².

The Musallam Farm is located along the Red Sea coast in Al-Khauba District (Al-Hudaidah Governorate). It covers an area of about 100 hectares and utilizes seawater to supply 100 earth pond each of 100 m². The farm employs 100 people including 4 aquaculturists and up to 30 technicians. The farm runs a semi-intensive system culturing shrimp at a density of 25 postlarvae/m². The target production is 6 tonnes/hectare. In 2005 the farm produced 380 tonnes of Indian white shrimp.

Goldlined seabream production started in 1990 and is important both for the domestic market as well as for export, albeit of secondary importance to shrimp production. The broodstock are collected from the fishing grounds at Fuqum in the Gulf of Aden during the spawning season in November. Hatching takes place between November and December. The juveniles are cultured for about one year before reaching the market size. Production of other finfish species has not yet been developed beyond the research stage due to technical difficulties.

The main destination of fishery products for domestic consumption are the wholesale markets at Hudgeef and Seera located in the fish port at Aden, as well as the Al-Hudaidah fish wholesale market in the port of Hudaidah (Hudaidah Governorate). Refrigerated trucks are seldom used to move fish. Fish are transported to the local markets and processing facilities with crushed ice. Shrimp is the main product from aquaculture and while there is a good domestic market, especially in hotels and restaurants, the markets in European, East Asia and the USA are the most lucrative.

Potential exists for further development of the sector, particularly if private companies are prepared to invest in research activities in cooperation with the Ministry of Fish Health and with those institutes engaged with the promotion and development of the sector.

