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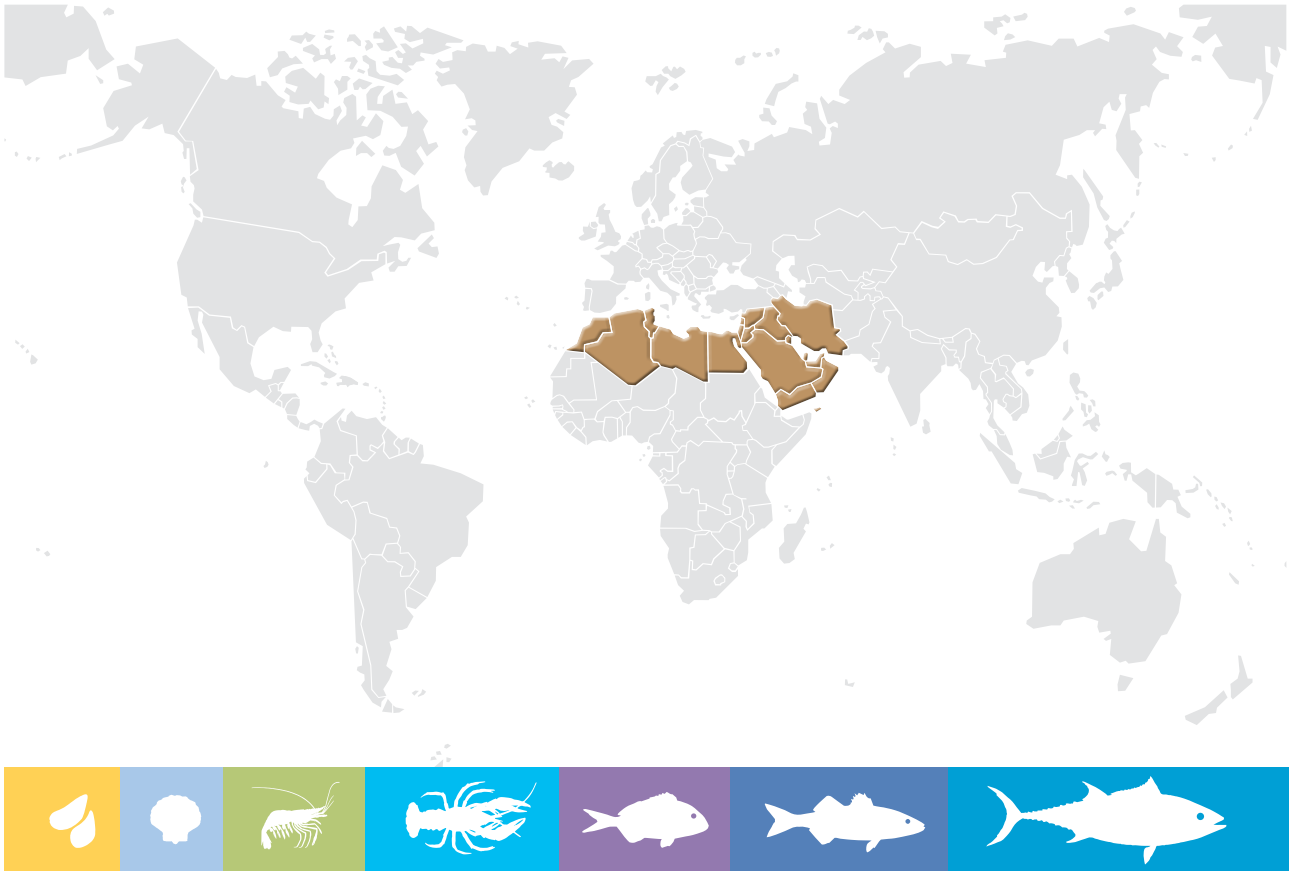

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REGIONAL REVIEW ON STATUS AND TRENDS IN AQUACULTURE DEVELOPMENT IN THE NEAR EAST AND NORTH AFRICA – 2015

by
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PREPARATION OF THIS DOCUMENT

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ABSTRACT

The Near East and North Africa (NENA) region comprises 20 countries with a total land area of about 12 million km^2. It is mostly desert and arid lands, with a total population of about 415 million people. All NENA countries have sea borders, but fresh water resources are very scarce. Except in the Arab Republic of Egypt and the Islamic Republic of Iran, the contribution of aquaculture to national gross domestic product (GDP) in the region is negligible. Aquaculture production in the NENA region has doubled over the past decade (2005–2014), from 702 340 tonnes in 2005 to 1 531 318 tonnes in 2014, with an average annual growth rate of 9.7 percent. However, Egypt and Iran contributed 74 and 21 percent, respectively, to total aquaculture output. Meanwhile, the role of aquaculture in total fish production is steadily increasing in the region. Aquaculture is currently restricted to about 45 aquatic species, with finfish representing 97 percent of total production. Nile tilapia (*Oreochromis niloticus*) is the most important farmed species; contributing 50 percent to total NENA aquaculture output in 2014, followed by carps (26 percent). Farming of marine species in brackishwater and seawater environments is also spreading and widely practiced. Extensive, semi-intensive intensive and integrated farming systems are adopted. The majority of fish farms in the NENA region are small-scale operations practiced mainly by the private sector; however, industrial scale marine and freshwater aquaculture is gaining considerable attention.

Aquaculture development in the NENA region is facing several constraints, including limited appropriate inland and costal lands, inappropriate freshwater fish hatchery installations and management, poor quality of produced seeds and poor handling and transportation. In the case of marine seed, there is a wide gap between seed production and farmers' demand. Most NENA countries also import their feed ingredients or processed fish feeds at high prices. NENA countries also do not possess animal health control systems for aquaculture. The access to credit, loans and insurance for aquaculture business is almost non-existent in most NENA countries. The expansion of the aquaculture industry in the region has increased environmental concerns and public awareness about food security issues and environmental conservation.

Substantial quantities of fish and fish products are imported annually in the region to cover the gap between fish production and consumption. The imports totaled 1 113 940 tonnes in 2013, representing 24.7 percent of total production and leading to a significant increase in per capita fish consumption, with a potential for further increase. However, the current contribution of aquaculture to fish consumption in the region is insignificant (except in Egypt and Iran). The contribution of aquaculture to the GDP in the region is also insignificant. In addition, the aquaculture sector is generally fragile and highly sensitive to external pressure, including environmental, economic, social and financial conditions. There are also several gaps in governance and management of the sector. In many countries, governance and regulation of the sector are carried out by more than one authority, leading to poor management strategies and policies and overlaps in fisheries and aquaculture legislation. In many cases specific laws and regulations are either nonexistent or they are outdated, weak or inactive. As far as Sustainable Development Goals (SDGs) and Blue Growth Initiative (BGI) are concerned, the aquaculture and fisheries sector in NENA region faces many challenges. They include lack of farmer's adaptability to climate change and resilience to natural disasters and socioeconomic risks, limited awareness on environmental and social impacts of aquaculture, and limited access to quality production inputs and sustainable production technologies. Most NENA countries have not created effective partnership with the FAO global BGI to face these challenges.

For complementary views on aquaculture in the Region, please see the Report from the COFI Sub-Committee on Aquaculture, Brasilia, Brazil, 3–9 October 2015, available at the following link: www.fao.org/cofi/43341-04a74a5d167de0034251e8eaf83de443e.pdf

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ABBREVIATIONS AND ACRONYMS

ANDA	Agence Nationale pour le développement de l'aquaculture
BGI	Blue Growth Initiative
BMPs	best management practices
DA	Department of Aquaculture
DIAS	Database on Introductions of Aquaculture Species
DoF	Department of Fisheries Resources
EIA	environmental impact assessments
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FCPs	Fishery Country Profiles
GCC	Gulf Cooperation Council
GDP	gross domestic product
GFCM	General Fisheries Commission for the Mediterranean
HABs	harmful algal blooms
MAAR	Ministry of Agriculture and Agrarian Reform
MOA	Ministry of Agriculture
MT	methyltestosterone
NALOs	National Aquaculture Legislation Overviews
NASOs	National Aquaculture Sector Overviews
NENA	Near East and North Africa
NGOs	non-Governmental Organizations
POC	particulate organic carbon
RAIS	Regional Aquaculture Information System
RPLA	Resource-Poor Labour-Abundant
RRLI	Resource-Rich Labour-Importing
RWR	renewable water resources
SAS	Saudi Aquaculture Society
SDGs	Sustainable Development Goals
Shilat	The Iranian Fisheries Authority
WGA-RECOFI	Working Group on Aquaculture of the Regional Commission on Fisheries
WSI	Water Scarcity Initiative

1. SOCIAL AND ECONOMIC BACKGROUND OF THE REGION

1.1 Status and trends

1.1.1 Scope and content

This document reviews the status and trends in aquaculture development in the Near East and North Africa (NENA) region. It updates the last Food and Agriculture Organization of the United Nations (FAO) "*Regional Review on Status and Trends in Aquaculture Development in the Near East and North Africa – 2010*" (FAO, 2011). It highlights the salient issues, particularly those that have evolved in the past decade (2010–2014).

The data contained in the review is based on FAO's official datasets (FAO, 2016a). Other local, regional and global information sources were also consulted throughout the review process. These included the FAO Fishery Country Profiles (FCPs), the National Aquaculture Sector Overviews (NASOs), the National Aquaculture Legislation Overviews (NALOs), the Database on Introductions of Aquaculture Species (DIAS), the World Bank and AQUASTAT. Regional fisheries and aquaculture management bodies and networks including the General Fisheries Commission for the Mediterranean (GFCM), the Working Group on Aquaculture of the Regional Commission on Fisheries (WGA-RECOFI) and the Regional Aquaculture Information System (RAIS) provided valuable information on the development of the aquaculture sector in the region. Additional information was also collected from trade magazines and other technical reports.

1.1.2 Geography and demography

The Near East and North Africa region spreads over Asia and Africa with some countries facing the Mediterranean Sea, while others the Indian and Atlantic Oceans. It occupies a land area of about 12 million km^2 (FAO, 2011) with a total population of approximately 415 million inhabitants (2015). All NENA countries have sea borders with coastlines ranging from 26 to over 2 600 km.

The dry NENA region comprises vast areas of desert and arid lands. The total desert area extends over 8 million km^2 representing 72 percent of the region's total land surface area. The proportion of dry areas extend from 20–25 percent in the Kingdom of Bahrain, the Republic of Tunisia and the Republic of Yemen, to 40–60 percent in the Islamic Republic of Iran, the Republic of Iraq, the Kingdom of Morocco and the Syrian Arab Republic, and up to 70–99 percent in the People's Democratic Republic of Algeria, the Arab Republic of Egypt, the Hashemite Kingdom of Jordan, the State of Kuwait, Libya, the Sultanate of Oman, the State of Qatar, the Kingdom of Saudi Arabia and the United Arab Emirates (FAO, 2011).

The NENA region comprises 20 countries, often geographically grouped into three sub-regions:

1. North African sub-region, comprising five countries (the People's Democratic Republic of Algeria, Libya, the Islamic Republic of Mauritania, the Kingdom of Morocco and the Republic of Tunisia);
2. Oriental Near East sub-region, comprising eight countries (the Arab Republic of Egypt, the Islamic Republic of Iran, the Republic of Iraq, the Hashemite Kingdom of Jordan, the Lebanese Republic, Palestine, the Republic of Sudan and the Syrian Arab Republic); and
3. Gulf sub-region groups seven countries (the Kingdom of Bahrain, the State of Kuwait, Sultanate of Oman, State of Qatar, Kingdom of Saudi Arabia, the United Arab Emirates and the Republic of Yemen).

The projected population of the region in 2050 is about 540 million. Except for the Republic of Yemen and the Arab Republic of Egypt, where 44 and 34 percent, respectively, of the population live in urban areas, an average 78 percent of the population of all NENA countries resides in urban areas. The average urban growth rate in the region increased by 19 percent from 2010–2014. This is attributable mainly to the increasing tendency of rural youth migrating to urban areas in search of higher education, employment opportunities and better infrastructure.

1.1.3 Health, education and nutrition

The health and education development levels in the NENA countries showed significant improvement during the past years. Despite this, the region as a whole has witnessed a setback in its fight against hunger. It is the only region that has seen an increase in the prevalence of hunger and a doubling in the number of hungry people, which now stands at 33 million. Despite high average calorie intakes, the NENA region continues to suffer from various malnutrition problems. Nonetheless, stunting rates have declined in several countries, such as the Islamic Republic of Mauritania (55 percent in 1990 to 22 percent in 2012), the Republic of Tunisia (31 in 1990 to 10 percent in 2012), the Kingdom of Morocco (30 percent in 1994 to 15 percent in 2011), the Sultanate of Oman (26 in 1991 to 10 percent in 2009) and the Kingdom of Saudi Arabia (21 percent in 1994 to 9 percent in 2005. However, at the other end of the malnutrition spectrum, nearly one-quarter of the population is considered obese, putting NENA among the regions with the highest prevalence of obesity globally (FAO, 2015).

The monitoring of education development goals showed improvement of relevant indicators. Both primary and secondary school enrollment of males and females showed slight increases. Concurrently, the illiteracy rate of both males and females decreased by about 50 percent during 2007–2015.

1.1.4 Socio-economic background of the region

The aggregate gross domestic product (GDP) at 2015 prices in the region[1] was estimated to be about US$2 873 billion, a 69 percent increase over the 2007 figure. The GDP of RRLI (Resource-Rich Labor-Importing) economies remains high, equalling US$1 427.7 billion (51 percent of total NENA GDP). The per capita GDP in this category ranged from US$4 650 (Libya) to US$74 509 (the State of Qatar), with an average of US$26 007. In RPLA (Resource-Poor Labour-Abundant) countries, the GDP was US$795 billion (28 percent of total GDP), with an average per capita GDP of US$3 867. For RPLA countries, the GDP reached US$571 billion (21 percent of total GDP), with a per capita GDP of US$4 345.

The contribution of the value-added agriculture sector, including the forestry and fisheries sub-sectors, to national GDP in the Near East and North Africa region in 2014 was relatively low (Table 1). This is mainly because the NENA region is mostly arid with little land suitable for agriculture. The agriculture value added ranged from 0.1 percent (the State of Qatar) to 14.5 percent (the Arab Republic of Egypt) with an average of 6.4 percent. This contribution was slightly reduced from the value recorded in 2007 (6.84 percent). On the other hand, the GDP contribution of aquaculture is almost negligible, except in the Arab Republic of Egypt and the Islamic Republic of Iran, where the contribution to the total GDP was 0.67 and 0.23 percent, respectively. Aquaculture value grew significantly from US$1 926 million in 2007 to US$3 457.8 million in 2014, an increase of 79.5 percent.

1.2 Issues

The NENA region is mostly desert and arid lands, with very scare fresh water resources. The projected population of the region in 2050 is about 540 million. The migration from rural to urban areas within NENA countries presents a major challenge facing the developmental plans. The average urban growth rate in the region has increased during the past few years. The average fertility rate is also higher than the global average. The contribution of the value-added agriculture sector, including forestry and fisheries subsectors, to national gross domestic product (GDP) in the NENA region is low. Except in the Arab Republic of Egypt and the Islamic Republic of Iran, aquaculture value/GDP in the region is almost nil.

[1] *Source:* The World Bank, 2016. Available at: http://data.worldbank.org/indicator/NY.GDP.MKTP.CD/countries

Table 1. Contribution of aquaculture production to national gross domestic product (GDP) in the Near East and North Africa region in 2015

Country	2007				2014			
	GDP (US Billion)	Agriculture value added /GDP (%)	Aquaculture value (US$ million)	% Aquaculture value/GDP	GDP (US Billion)	Agriculture value added /GDP (%)	Aquaculture value (US$ million)	% Aquaculture value/GDP
Algeria	134.3	7.7	1	0.0007	213.5	11.1	10.6	0.0050
Bahrain	18.5				33.6			
Egypt	137.5	14.1	1 193	0.87	301.5	14.5	2 025	0.67
Iran (Islamic Republic of)	290.0	7.4	451	0.16	425.2	9.3	967	0.23
Iraq	21.3	na	35	0.16	223.5		159	0.07
Jordan	17.0	2.8	3	0.01	35.8	3.8	9.3	0.026
Kuwait	112.0	na	1	0.001	163.6	0.4	2	0.001
Lebanon	24.0	5.3	2	0.01	45.7	5.5	3.5	0.008
Libya	62.7	na	1	0.002	41.1			
Mauritania	3.4	25.6			5.4	20.8		
Morocco	75.2	12.2	6	0.008	110.0	16	9.5	0.009
Palestine	4.9	na	20.	0.004	12.7	4.8	1.9	0.015
Oman	41.6	1.4	1	0.002	81.8	1.3	1.8	0.0023
Qatar	71.0	0.1		0.0002	210.1	0.1	0.2	0.0
Saudi Arabia	383.6	2.8	186	0.049	753.8	1.9	179	0.033
Sudan	45.9	26.7	3.84	0.008	73.8	29.2	6.93	0.015
Syrian Arab Republic	40.2	17.9	24	0.06	48.6		9.9	0.02
Tunisia	35.6	9.4	18	0.052	399.4	8.8	73.5	0.02
United Arab Emirates	198.7	1	4	0.002	399.5	0.7	5.6	0.001
Yemen					213.5	11.1		
NENA region	1 422.5	6.72	1 926		3 792.1	7.0	3457.8	

Source: The World Bank. Available at: http://data.worldbank.org/indicator/NV.AGR.TOTL.ZS

1.3 The way forward

One of the greatest challenges facing NENA governments is to sustain the livelihood of the populations in this arid and resource-poor region. Increase rural development programmes are required, in order to reduce the migration from rural societies into urban areas. The progress in health and education development levels in the NENA countries has been evident; this development should continue with the same pace. Efforts have to be made to build resilience to adapt to disasters, climate change and variability. Countries in the NENA region must increase the contribution of agricultural sector, including fisheries and aquaculture to national gross domestic product. An enhancement and revision of the entire value chain is required.

2. GENERAL CHARACTERISTICS OF THE SECTOR

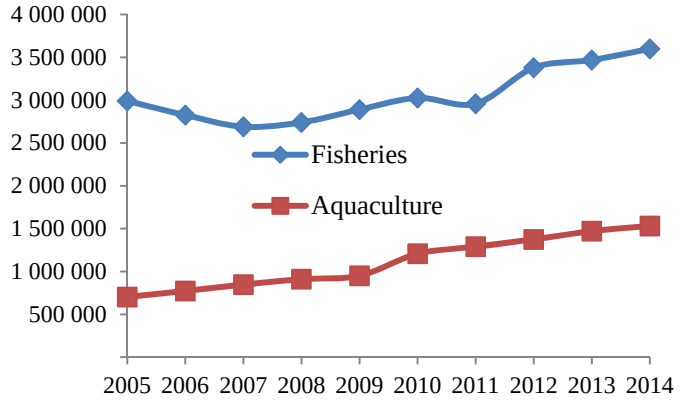
2.1 Status and trends

Aquaculture as an industry in the Near East and North Africa (NENA) region is relatively new, except in the Arab Republic of Egypt where aquaculture has been practiced for many centuries (Bardach, Ryther and McLarney, 1972). Modern commercial aquaculture in the region started in the 1950s and 1960s, while the real development and expansion of the industry has been taking place during the past three decades. Nonetheless, aquaculture in some NENA countries is still in its infancy.

2.1.1 Production volume and trend

Aquaculture production in the NENA region has doubled over the past decade (2005–2014), from 702 340 tonnes in 2005 to 1 531 318 tonnes in 2014, showing an average annual growth rate of 9.7 percent (Figure 1). Despite this sharp increase in production volume, the annual growth rate has actually declined, from the 21.4 percent recorded during the previous decade (1995–2004).

Figure 1. Aquaculture and capture fisheries production in NENA region during 2005–2014



Source: FAO, 2016a.

The contribution of individual NENA countries to the total regional production varies widely, ranging from only a few tonnes to over a million tonnes (Table 2). Therefore, these countries can be categorized into four categories:

1. Large-scale producers, with an annual output of over 200 000 tonnes (the Arab Republic of Egypt and Islamic Republic of Iran);
2. Medium-scale producers, with an annual production of 5 000 to 35 000 tonnes (the Republic of Iraq, the Kingdom of Saudi Arabia and the Republic of Tunisia);
3. Small-scale producers, with an annual production of 1 000 to 5 000 tonnes (the People's Democratic Republic of Algeria, the Lebanese Republic, the Kingdom of Morocco, the Republic of Sudan and the Syrian Arab Republic); and
4. Very small producers, with an annual production of less than 1 000 tonnes (the Kingdom of Bahrain , the Hashemite Kingdom of Jordan, the State of Kuwait, the Lebanese Republic, Libya, the Islamic Republic of Mauritania, the Sultanate of Oman, Palestine, the State of Qatar, United Arab Emirates and the Republic of Yemen).

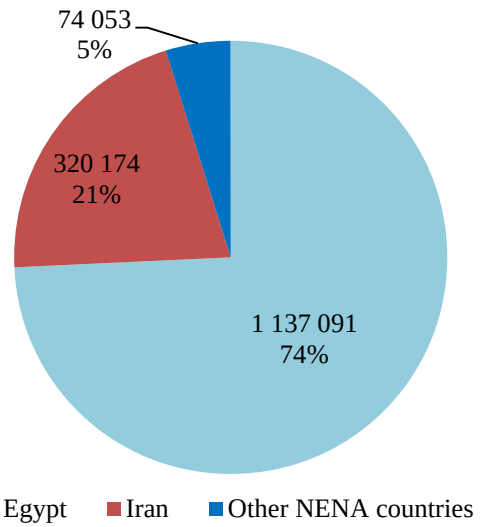
Table 2. The contribution of aquaculture (tonnes) to total fish production in NENA in 2014

Country	Fisheries production	Aquaculture production	Total production	% aquaculture
Algeria	97 741	2 411	100 152	2.41
Bahrain	15 854	6	15 860	0.04
Egypt	344 792	1 137 091	1 481 883	76.73
Iran (Islamic Republic of)	627 180	320 174	947 354	33.79
Iraq	59 000	26 625	85 625	31.09
Jordan	873	885	1 758	50.34
Kuwait	4 600	297	4 897	6.06
Lebanon	2 998	1 125	4 123	27.29
Libya	25 004	10	25 014	0.04
Mauritania	378 339	–	378 339	0
Morocco	1 367 841	1 189	1 369 030	0.09
Oman	211 037	282	211 319	0.13
Palestine	2 854	240	3 094	7.76
Qatar	16 213	56	16 269	0.34
Saudi Arabia	68 660	23 880	92 540	25.80
Sudan	34 008	1 980	35 988	5.5
Syrian Arab Republic	4 300	3 000	7 300	41.09
Tunisia	112 047	11 279	123 326	9.15
United Arab emirates	70 000	788	70 788	1.11
Yemen	190 000	0	190 000	0
NENA region	3 633 341	1 531 318	5 164 659	29.65

Source: FAO, 2016a.

The contribution of aquaculture in the NENA region to global aquaculture production remains low at about 2.6 percent in 2014. Aquaculture output is dominated by two countries: the Arab Republic of Egypt and the Islamic Republic of Iran. These two countries contributed 95 percent (74 and 21 percent, respectively) to the region's output in 2014. If the production of these two countries is discounted, NENA's contribution to global aquaculture output declines to 0.13 percent (Figure 2).

Figure 2. Aquaculture output (tonnes and percent) by major producers in NENA region in 2014



Source: FAO, 2016a.

On the other hand, the contribution of aquaculture to total fish output in NENA varies widely at country levels. In 2014, aquaculture contribution was almost nil in the Kingdom of Bahrain, Libya, the Islamic Republic of Mauritania, the Kingdom of Morocco, the Sultanate of Oman, the State of Qatar and the Republic of Yemen. These countries have relatively small populations, and the production of capture fisheries meets the consumer's demand. On the other hand, aquaculture represented a significant contribution to total fisheries output in the Arab Republic of Egypt (76.7 percent), the Hashemite Kingdom of Jordan (50.3 percent), Islamic Republic of Iran (33.8 percent), the Republic of Iraq (31 percent), the Lebanese Republic (27.3 percent), the Kingdom of Saudi Arabia (25 percent) and the Syrian Arab Republic (41.1 percent). These values are higher than the values reported in 2007, indicating that the role of aquaculture in total fish production is steadily increasing.

The contribution of aquaculture to total fishery production has been increasing at a high rate, with an average annual rate of 28.1 percent, compared to 21.4 percent during 1995–2004 period (Figure 1). The production of capture fisheries has been fluctuating between 2.47 and 3.6 million tonnes during 2005–2014, with an average annual growth rate of 2.14 percent.

2.1.2 Cultured species

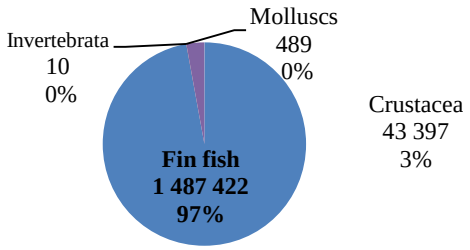
Over 70 aquatic animal species, including finfish, crustaceans and molluscs are farmed in NENA region, for commercial purposes as well as research. Currently, aquaculture is restricted to about 45 species and is dominated by finfish, which represented 97 percent of total aquaculture production in 2014 (Table 3 and Figure 3). Nile tilapia (*Oreochromis niloticus*) has by far been the most important farmed finfish during 2005–2014 with an average annual growth of 16.3 percent (Figure 4). Nile tilapia alone contributed 50 percent to total NENA's aquaculture output in 2014, followed by cyprinids (common carp, silver carp, grass carp and bighead carp), which contributed 26 percent. Farming of marine species including mullets (flathead grey and thinlip mullet), gilthead seabream and European seabass in brackishwater and seawater environments is also widely practiced. Rainbow trout is the only temperate fish species grown in NENA, mainly in the Islamic Republic of Iran and the Lebanese Republic and smaller volumes in the Kingdom of Morocco.

Table 3. Total production increment of major cultured species from 2005 to 2014 in the Near East and North Africa region

Species		Origin Native/ exotic	Production (tonnes)		Growth increment (%)
Common name	**Scientific name**		**2005**	**2014**	
Nile tilapia	*Oreochromis niloticus*	N/E	221 127	768 271	16.4
Cyprinids nei		N/E	143 806	153 629	48.9
Rainbow trout	*Oncorhynchus mykiss*	E	35 518	127 715	16.0
Common carp	*Cyprinus carpio*	E	31 194	125 787	17.3
Mullets	*Mugil cephalus*	N	161 513	119 647	-0.5
	Liza ramada	N			
Silver carp	*Hypophthalmichthys molitrix*	E	43 540	85 439	8.3
Whiteleg shrimp	*Penaeus vannamei*	E	10	35 465	1 959.2
Gilthead seabream	*Sparus aurata*	N	5 880	27 869	43.0
European seabass	*Dicentrarchus labrax*	N/E	6 061	17 449	38.6
Grass carp	*Ctenopharhyngodon idella*	E	13 230	17 307	5.5
Bighead carp	*Aristichthys nobilis*	E	3 670	17 034	21.6

Source: FAO, 2016a; FAO, 2006–2011. Database on Introductions of Aquaculture Species – DIAS. Available at: www.fao.org/fishery/dias/en

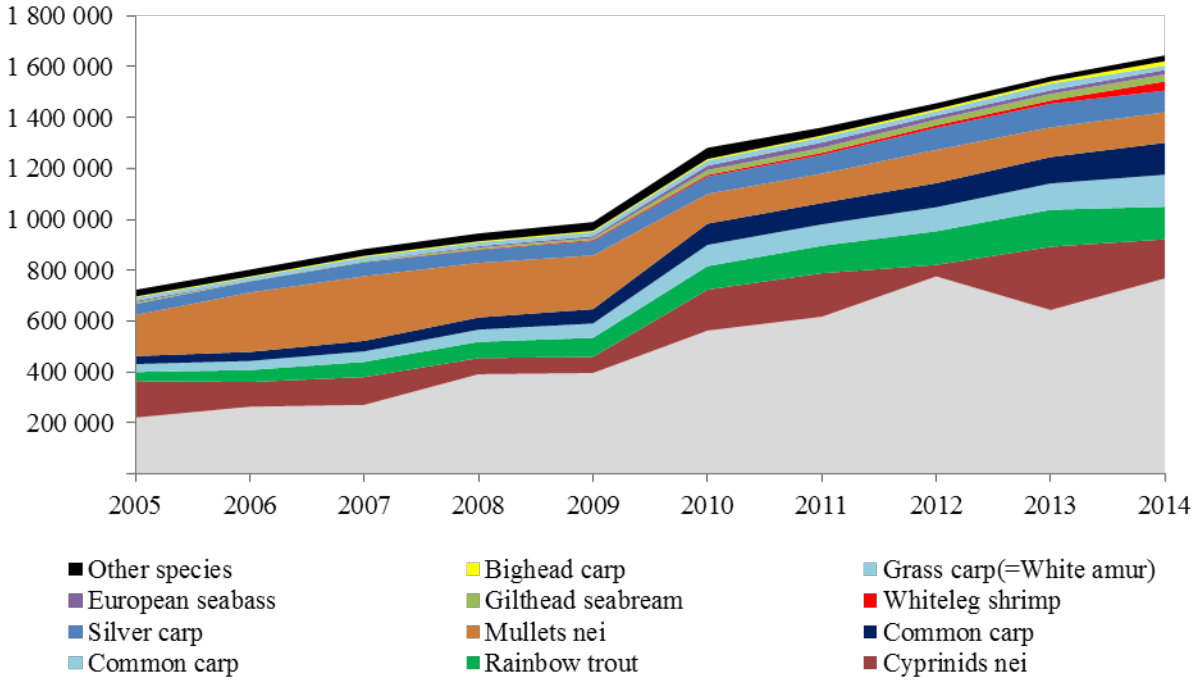
Figure 3. Production of cultured groups in NENA region in 2014



Source: FAO, 2016a.

Penaeid shrimps are also farmed in the NENA region, but at limited scale. Whiteleg shrimp (*Penaeus vannamei*) is currently the most widely farmed species, especially in the Kingdom of Saudi Arabia and in the Islamic Republic of Iran. Other penaeid shrimps including Indian white prawn (*P. indicus*) and tiger prawn (*P. monodon*), in addition to the freshwater giant river prawn (*Macrobrachium rosenbergii*) are also farmed, but at much smaller scale.

Figure 4. Production of major farmed species during 2005–2014



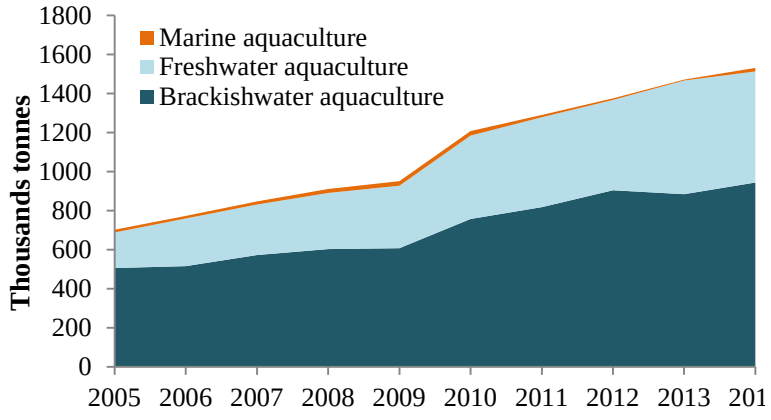
Source: FAO, 2016a.

The major species cultured in the NENA region are mostly native to one or more countries in the Near East and North Africa (Table 3). Some native species of the North African sub-region, such as the Nile tilapia and the African catfish, have been introduced in the Oriental Near East sub-region. In addition, the European seabass (*Dicentrarchus labrax*) and gilthead seabream (*Sparus aurata*) have been introduced in the Gulf Countries for aquaculture purposes. Similarly, several carp species have been introduced to most of the region's countries. Several sturgeon species have been introduced to several Gulf nations (the Kingdom of Saudi Arabia and the United Arab Emirates), where they are farmed mainly for caviar. Most exotic species have adapted to local aquatic environments and are currently widely farmed at a commercial scale, with significant contribution to aquaculture outputs.

2.1.3 Production environments

Brackishwater has been the leading fish-producing environment in the NENA region during the 2005–2014 period, with an annual growth rate of 7.4 percent (Figure 5). In 2014, brackishwater production represented 62 percent of the total aquaculture yield. The Arab Republic of Egypt is dominating aquaculture production in this environment with a contribution of 96 percent over the same year.

Figure 5. Aquaculture production by environment in NENA region during 2005–2014



Source: FAO, 2016a.

The freshwater environment contributed 37 percent to total aquaculture output in 2014. The growth rate from this sub-sector was much higher (14.2 percent) compared to brackishwater systems during the same period. This was mainly due to the contribution

of the Islamic Republic of Iran and the Arab Republic of Egypt. The former country tops in freshwater fish production with an average annual growth rate of 12 percent during 2005 to 2014. The Arab Republic of Egypt comes second, with an average annual growth rate of 36 percent.

Considerable developmental efforts have been channelled to marine aquaculture in the NENA region over the past years, particularly in Gulf countries. However, marine aquaculture production fluctuated sharply during 2005–2014. An exceptional increase in marine aquaculture production was recorded in 2014, due to the production of whiteleg shrimp (*P. vannamei*) in the Kingdom of Saudi Arabia, which began in that same year. The Kingdom of Saudi Arabia alone contributed 95 percent to total marine aquaculture yield in 2014.

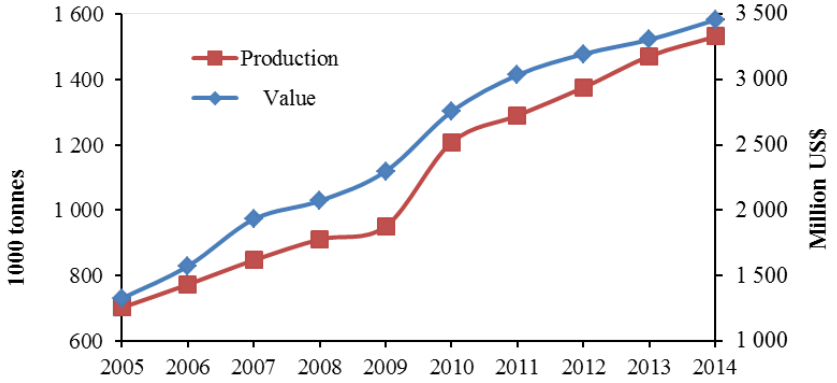
2.1.4 Production value

The value of aquaculture output in the NENA region increased from US$1.33 billion in 2005 to US$3.47 billion in 2014, with an annual growth rate of 11.4 percent (Figure 6). The Arab Republic of Egypt alone contributed 58.4 percent, followed by the Islamic Republic of Iran (27.9 percent), the Kingdom of Saudi Arabia (5.2 percent), the Republic of Iraq (4.6 percent) and the Republic of Tunisia (2.1 percent). The contribution of the other 15 NENA countries remained negligible.

2.1.5 Production systems and technologies

Aquaculture production systems applied in the Near East and North Africa region include extensive, semi-intensive and intensive culture methods. The integration of aquaculture with land crops and/or animal production is also practiced. Recirculating and aquaponics systems are gaining increased attention, especially in the desert and arid areas. The majority of fish farms in the NENA region are small-scale operations, although industrial scale facilities characterize the marine aquaculture sector (see cage faming in the Kingdom of Saudi Arabia, the Republic of Tunisia, the People's Democratic Republic of Algeria). Farming activities are practiced mainly by the private sector. Aquaculture systems commonly used in the NENA region are described below.

Figure 6. Aquaculture production and values in NENA region during 2005–2014



Source: FAO, 2016. www.fao.org/fishery/statistics/global-commodities-production/query/en

2.1.5.1 Extensive aquaculture systems

Extensive fish culture in the NENA region is based mainly on stocking inland water bodies with fish juveniles either captured or hatchery-produced. Small, permanent lakes, surface water retention lakes, dams, reservoirs and seasonal lakes are widely used for this purpose in the People's Democratic Republic of Algeria, the Arab Republic of Egypt, Islamic Republic of Iran, the Republic of Iraq Libya, the Kingdom of Morocco and the Syrian Arab Republic. Stocked fish species typically consist of the common carp (*Cyprinus carpio*), grass carp (*Ctenopharyngodon idella*), silver carp (*Hypophthalmichthys molithrix*) and occasionally tilapia.

2.1.5.2 Semi-intensive aquaculture systems

Semi-intensive aquaculture in the NENA region is practiced exclusively in earthen ponds using natural food (through pond fertilization) or fertilization and supplemental feeding. Such systems are adopted mainly for herbivorous and omnivorous fishes that feed low in the food chain, such as tilapias, mullets and carps. These systems prevail in the Arab Republic of Egypt, Islamic Republic of Iran, the Republic of Iraq and the Syrian Arab Republic. In the Arab Republic of Egypt, semi-intensive fish culture is by far the most important farming system that contributed between 72 to 93 percent of total aquaculture production during 2005–2014. Monoculture of Nile tilapia (mainly all-male) in brackishwater represents about 90 percent of total tilapia production. Co-culture of tilapia, common carp, and flathead mullet is also widely practised; however, tilapia remains the main target species, representing 75–90 percent of the stocked fishes.

Polyculture of carps (common carp, grass carp, silver carp and bighead carp) in earthen ponds is the main form of semi-intensive aquaculture in the Islamic Republic of Iran and the Republic of Iraq. Shrimp farming is also practiced semi-intensively in earthen ponds in the Islamic Republic of Iran. In the Syrian Arab Republic, semi-intensive culture of carps species and Nile tilapia in freshwater ponds is widely practiced. In the Kingdom of Saudi Arabia, the semi-intensive method is largely used for shrimp culture in earthen ponds.

2.1.5.3 Intensive aquaculture systems

Intensive aquaculture in cages, tanks, raceways, ponds and recirculating systems is widespread in most NENA countries. This practice entails very high costs. Therefore, the use of intensive culture systems is generally restricted to the production of high-value species such as European seabass, gilthead seabream, rainbow trout and shrimp, especially in Gulf countries, the Lebanese Republic and the Maghreb countries.

Intensive aquaculture practices in cages, tanks, raceways and recirculating systems are briefly described below.

a- Intensive fish culture in floating cages

Fish culture in floating cages has been rapidly spreading in the Arab Republic of Egypt over the past few decades, particularly in Damietta and Rosetta branches of the Nile River. Consequently, cage production rapidly increased from 3.7 percent of total Egyptian aquaculture production to 15.5 percent in 2014 (GAFRD, 2016). Silver carp and Nile tilapia are the major farmed species; a few tonnes of European seabass and mullets were also produced in floating cages in 2014.

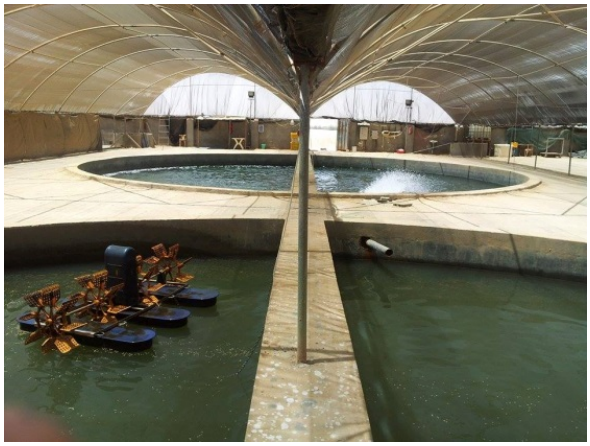
Marine cage culture of European seabass and gilthead seabream is practiced in Maghreb countries (i.e. the People's Democratic Republic of Algeria, the Kingdom of Morocco and the Republic of Tunisia). Currently, rainbow trout is farmed in the Islamic Republic of Iran in floating cages in lakes and in the Caspian Sea.

Marine cage culture has been developing in the Gulf, Red Sea and Oman Sea, mainly for faming the Asian seabass or barramundi (*Lates calcarifer*). Other species of interest in the region include several species of grouper (Serranidae), Sobaity bream (*Sparidentex hasta*), cobia (*Rachycentron canadum*), silver pomferet (*Pampus argenteus*) and fourfinger threadfin (*Eleutheronema tetradactylum*), but their production remains low. In the Kingdom of Saudi Arabia, offshore cages have received considerable support from the institutions, and a number of large commercial farms have been established over the past five years, mainly farming the Asian seabass and the gilthead seabream.

b- Intensive culture in raceways, tanks and recirculating systems

Intensive aquaculture in raceways, tanks and recirculating systems is most suitable in situations where water resources are limited, such as in desert and arid lands (Figure 7a and b). These systems are gaining great momentum in the Gulf region and North Africa. A number of intensive tilapia farms in concrete tanks are also in operation in the Arab Republic of Egypt and United Arab Emirates. Intensive culture of rainbow trout is practiced in recirculation production systems in the Islamic Republic of Iran and in earthen ponds or concrete flow-through raceways in the Lebanese Republic.

Figure 7a. Farming European seabass in Egypt in concrete tanks



Courtesy of: M. Abdel-Hady

Figure 7b. Farming Nile tilapia in Saudi Arabia in concrete tanks

Courtesy of: A-F.M. El-Sayed

In the Maghreb countries, intensive aquaculture trials have been carried out successfully. Gilthead seabream and European seabass are intensively farmed in the marine environment in the Republic of Tunisia and more recently also in the People's Democratic Republic of Algeria. The African catfish and the whiteleg shrimp are farmed intensively in the People's Democratic Republic of Algeria using underground fresh and saline.

2.1.5.4 Integrated aquaculture

The shortage of freshwater in NENA region makes the integration of aquaculture with land crops and domestic animals a necessity, and results in diversification of farm outputs through the full utilization of available resources and wastes. Fish-rice culture, fish-wheat culture and fish culture with land animals are the most popular integrated farming systems.

a- Fish-rice and fish-wheat farming

Fish-rice farming in NENA region is practiced exclusively in the Arab Republic of Egypt, where rice is a major food crop (Figure 8). This practice has proven successful and profitable. The production of fish in rice fields increased from 10 000 tonnes in 1999 to almost 34 000 tonnes in 2014, representing about 3 percent of total aquaculture production (GAFRD, 2016). Common carp, tilapia and the African catfish are currently the only fish species reared in rice fields. Overall average fish production per hectare is still relatively low (115 kg/ha in 2014) (GAFRD, 2016). Fish culture in paddies (following the harvesting of rice) and irrigation reservoirs is also practiced in some parts of the Islamic Republic of Iran.

Figure 8. Rice-fish farming in the Nile delta region, the Arab Republic of Egypt

Courtesy of: G.O. El-Naggar.

In the Arab Republic of Egypt, pond-farmed tilapia are generally harvested in November and December because the water temperature during winter becomes unfavourable for the survival of the fish. Tilapia farmers in some areas use their empty ponds during the winter months to grow wheat (and sometimes alfalfa; locally known as barseem). The approach is highly productive- and water-efficient (Figure 9) (van der Heijden, 2012).

Figure 9. Growing (left) and harvesting and threshing (right) wheat crop grown in tilapia ponds in Kafr El-Shaikh governorate, the Arab Republic of Egypt

Courtesy of: A.-F.M. El-Sayed.

b- Integrated aquaculture in the desert

Integrated aquaculture/agriculture in Egyptian deserts has also been expanding rapidly in recent years. Currently, more than 20 pioneer commercial fish farms in Egyptian deserts are integrated with the agriculture irrigation system and animal production using underground water (Sadek, 2011). In these systems, underground water with a salinity of 2–4 parts per thousand is used to irrigate land crops (such as corn, alfalfa, vegetables, fruits and flowers) along with fish monoculture or polyculture (tilapia, carps and mullets).

In the Sultanate of Oman, the integrated culture of Nile tilapia is practiced in various areas, in particular in the northern part of the country. There are 10 integrated tilapia farms in the Sultanate of Oman, expected to produce 36 tonnes/year in cement ponds. In 2013, a multi-million dollar multi-species integrated aquaculture farm was launched in Ras Jibsh along the Arabian Sea coast.

c- Aquaponics

Aquaponics, the integration of hydroponics with aquaculture in a recirculating system, is emerging as an appropriate integration system where land is expensive, water is scarce, and soil is poor. This system is appropriate in NENA arid areas where no or very little land and water resources are available for agriculture. The system is now developing in several NENA countries. A large aquaponics farm has recently been built in the United Arab Emirates. The system relies on raising tilapia in tanks and using their wastewater for irrigating horticulture crops. A similar large public aquaponics project was launched in the Barka region within the Governorate of Muscat, the Sultanate of Oman, in 2012 using tilapia as the farmed fish species.

2.2 Issues

Freshwater resources and sites suitable for aquaculture in NENA region are limited. This makes inland aquaculture in the region more difficult. The limited number of farmed species is also a major constraint to aquaculture development in the NENA region. Despite over 45 fish species being currently farmed in the region, about 95 percent of aquaculture output comes from tilapia, carps, mullets and rainbow trout. Quality seeds and feed also remains a major challenge facing aquaculture development in the region. The sector largely depends on imported feed ingredients and processed feeds. The acquisition of advanced aquaculture technologies and know-how, especially in marine

aquaculture, is still lagging behind and relies on importing foreign expertise. Finally, the sector lacks trained personnel, modern culture facilities and technical research support.

2.3 Success stories

Aquaculture/agriculture integration in Egyptian desert

Rula for Land Reclamation in Wadi El-Natroun (Western Desert) and El-Keram Farm in Tahrir Directorate, Behaira, are excellent examples of aquaculture/agriculture integration. In the Rula Farm, Nile tilapia, red tilapia and freshwater prawn are farmed in raceways and tanks using underground water while the effluent water is used to irrigate olive trees. El-Keram Farm grows tilapia and catfish in cement tanks of different sizes and shapes. Effluent water, enriched with organic fish wastes, serves as fertilizer for fodder crops. This system produces three different crops from the same quantity of water (Sadek, 2011).

Introduction of aquaponics technology in the United Arab Emirates

One of the world's largest aquaponics farms (4 000 m^2) has recently been built in the desert off Abu Dhabi. The system relies on raising tilapia in tanks and using their wastewater for irrigation and nutrition for a wide array of vegetables. The plants act as a natural filter for the water, while at the same time extracting the nutrients they need. Nutrient-free water is then pumped back to fish tanks to complete the cycle. The vegetables are currently sold in supermarkets and restaurants across Abu Dhabi. This type of technology can be easily transferred to similar arid land areas, and may well change the future of agriculture in the region.

Shrimp farming in the desert of the People's Democratic Republic of Algeria

The Sahara Golden Shrimp production is housed at the Ouargla Shrimp Cultivation Research Centre (the People's Democratic Republic of Algeria), in a desert area outside the city of Ouargla, 800 km south the Mediterranean coast. The facility includes both indoor and outdoor systems. Indoor facilities consist of three raceways (80 m^2 each) and three circular tanks (25 m^2) with well-established aeration and piping systems to foster uniform and consistent biofloc for shrimp culture. Upon completion of the acclimation process, a biofloc recirculation system is used for the shrimp growout phase. The stocking density of whiteleg shrimp (*Penaeus vannamei*) was between 150 to 300/m^2, which yielded a harvest of 500 kg per production unit in January 2016 with harvest shrimp size of 23 grams. Water used for rearing the shrimp is the local underground well water with a salinity of 2 ~ 4 parts per thousand drawn from a depth of approximately 100 meters. Encouraged by this recent demonstration farm success, the Algerian Government plans to develop more extension farms in oasis areas in five adjacent regions in the country, and aims to produce 2 000 tons of shrimp by 2020.

2.4 The way forward

The further development of a sustainable aquaculture industry in the NENA countries still requires substantial efforts. Research on nutrient requirements and feed and feeding management of farmed species and development of new aquaculture technologies remain top priority. Diversification of the species cultured through the identification of new local/exotic species that have high aquaculture potential should also be encouraged. Marine aquaculture should be further supported so to make full use of the marine environment. This approach has already been recently adopted in the Gulf Cooperation Council (GCC) countries. The Sultanate of Oman, the Kingdom of Saudi Arabia and United Arab Emirates have already started large marine aquaculture projects. More efforts should also be paid to building the capacity of aquaculture manpower, and creating new generations of skilled personnel. Ensuring strong national aquatic biosecurity programmes remains an important developmental area for many countries in the region.

3. RESOURCES, SERVICES AND TECHNOLOGIES

3.1 Status and trends

3.1.1 Land

All NENA countries have sea borders, with national coastline length ranging from 26 to over 2 600 km. The region has also two main river systems: the Nile system in the African sub-region and the Euphrates-Tigris system in the Near East sub-region. Most of the land in NENA region is not suitable for agriculture. Only 30 percent of the total land is suitable for traditional agricultural practices. An estimated 85 percent of this agricultural land is used for meadows and pastures (FAO, 2014).

Within the NENA region, arable land covers an area of about 520 000 km^2, representing about 13.7 percent of total agricultural land area. However, the percentage of arable agricultural land varies significantly from one country to another. In the GCC countries and the Republic of Yemen, the percentage of arable agricultural land is only 2.2 percent. The Arab Republic of Egypt has the lowest percentage of agricultural land to total area in the region (3.7 percent), but most of this land is arable (78.3 percent). The Republic of Iraq has the next highest percentage (48.7 percent) (FAO, 2014).

The area of permanent crops in the NENA region represents only 2 percent of total agricultural land. The Republic of Tunisia and the Arab Republic of Egypt are the only two countries in the region with significant areas of agricultural land under permanent crops (23.8 and 21.7 percent, respectively). Forests also cover only about 1.9 percent the region's total land area, accounting for only 0.6 percent of the world's total forest resources. Only the Lebanese Republic and the Kingdom of Morocco have more than 10 percent forest cover, while seven percent in the case of the Islamic Republic of Iran. In the rest of NENA countries, forests cover less than one percent of the total land area.

3.1.2 Fresh water

Freshwater resources in the NENA region are scarce and large areas of the region receive extremely low natural precipitation. The Islamic Republic of Iran, the Lebanese Republic and the Syrian Arab Republic receive about 40 percent of the region's rainfall. Agricultural production in the region relies mainly on irrigation. Freshwater withdrawal for agriculture purposes accounts for about 78 percent of the region's water withdrawals (FAO, 2014).

Irrigated lands represent about two percent of the total NENA region, and are restricted to areas with surface water resources or supplied with underground water. The share of irrigated land area ranges from seven percent in countries with enough precipitation to 100 percent in desert countries (FAO, 2011). The Islamic Republic of Iran has the largest irrigated area, at over 9 million hectares, and the most potential for irrigation expansion. The Arab Republic of Egypt and the Republic of Iraq have the next highest potential for increasing irrigation (Table 4).

Irrigation water in the NENA region is mainly surface water from large rivers including the Nile in North Africa and the Euphrates and the Tigris in the Middle East. Groundwater is most important in the Arabian Peninsula and the Maghreb countries (the People's Democratic Republic of Algeria, Libya, the Kingdom of Morocco and the Republic of Tunisia), where there are no large rivers. Groundwater also plays a significant role in the Islamic Republic of Iran.

According to the FAO Regional Initiative on Water Scarcity for the Near East and North Africa (WSI), the NENA region will be exposed to further severe water scarcity issues in coming decades. Per capita freshwater availability, which has already decreased by two thirds over the last 40 years, will likely decrease further by another 50 percent by 2050. Furthermore, more frequent, intense and long droughts have been observed in the NENA region during the past decades as a result of climate change. Agriculture, which consumes over 85 percent of available freshwater resources, will need to face tough challenges in keeping the same water allocation while sustaining food security and rural

economy. Similarly, freshwater aquaculture will face the same challenges. Therefore, better use, and responsible management, of water resources through the integration of aquaculture with other agricultural activities will be inevitable. For this reason, brackishwater and marine aquaculture should be given more attention.

Table 4. Land and water sources in NENA region 2013

Country	RWR (km^3/year)*	irrigated land (1000 ha)*	Cultivated area (1000 ha)**	% of total area cultivated**
Algeria	11.67	1 230	8 435	3.54
Bahrain	0.116	6.06	4.6	5.97
Egypt	58.3	3 610	3 761	3.756
Iran (Islamic Republic of)	137	8 700	16 684	9.56
Iraq	89.86	3 525	5 230	12.02
Jordan	0.937	83.45	314.6	3.522
Kuwait	0.02	10.14	17.6	0.9877
Lebanon	4.5	104	258	24.69
Libya	0.7	400	2 055	1.168
Mauritania	11.4	45.01	108.8	10.95
Morocco	29	1520	9 401	21.05
Oman	1.4	58.85	68.5	0.2213
Palestine	0.837	24	112	18.6
Qatar	0.058	12.94	17.61	1.517
Saudi Arabia	2.4	1620	3 295	1.533
Sudan	37.8	1 852	17 365	8.71
Syrian Arab Republic	16.8	1 341	5 733	30.96
Tunisia	4.615	486.6	5 129	31.35
United Arab Emirates	0.15	92	77.3	0.9246
Yemen	2.1	680.1	1 546	2.928

* www.fao.org/nr/water/aquastat/countries/index.stm. RWR= renewable water resources

** www.fao.org/nr/water/aquastat/countries_regions/Profile_segments/index.stm

3.1.3 Seed supply

3.1.3.1 Freshwater seed

At present, freshwater seed supply (mainly tilapia and carps) is sufficient in most NENA countries. Governmental and private hatcheries are abundant, although many of them still operate on rather rudimental farming technologies.

The Arab Republic of Egypt is the most important aquaculture producer in the region, and seed supply in the country is worth highlighting. There were 13 governmental freshwater fish hatcheries and 93 licensed private tilapia hatcheries in operation in 2014 (GAFRD, 2016). In addition, there are more than 500 operational, but unlicensed, private hatcheries, many of which have been established in recent years (Macfadyen *et al.*, 2011). The total annual number of hatchery-produced fry varied between 270 and 560 million during 2005–2014 (GAFRD, 2016). Hatchery-produced seed in the Arab Republic of Egypt is restricted to freshwater species, particularly tilapia and carps, and to a lesser extent, the African catfish (Figure 10).

Freshwater hatcheries (mainly for carps) are also abundant in the Republic of Iraq, the Islamic Republic of Iran and the Syrian Arab Republic, where carp represent a major farmed species. The majority of carp farmers in these countries are self-supplied with fish seed, but they apply simple

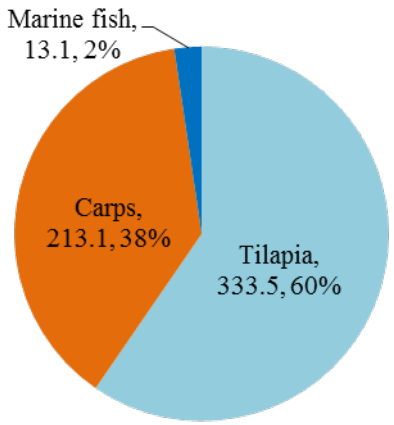
technologies with little innovation. Countries that produce several hundred tonnes of carps (e.g. the Hashemite Kingdom of Jordan) also operate their own hatcheries.

3.1.3.2 Marine seed

Most NENA countries lack the technologies for marine seed production. Substantial quantities of marine seed (mainly gilthead seabream and European seabass) are either imported or collected from the wild. The Arab Republic of Egypt has a few marine hatcheries producing seabream, seabass and mullet seed, with a production of 13.1 million in 2014 (GAFRD, 2016) (Figure 10). However, most marine seed is collected from the wild (72 million fry in 2014).

In the Kingdom of Saudi Arabia aquaculture companies also produce their own fish and shrimp seed locally. At the moment, different research programmes are ongoing in four GCC countries (the Kingdom of Bahrain, the Sultanate of Oman, the State of Kuwait and the Kingdom of Saudi Arabia) and in the Islamic Republic of Iran on development of marine hatchery technologies for native species for aquaculture purposes and for enhancing natural stocks.

Figure 10. Hatchery-produced seeds (million fry) in the Arab Republic of Egypt in 2014



Source: GAFRD, 2016.

3.1.4 Potential cultured species

A number of freshwater fish species have high potential for aquaculture, such as Nile perch (*Lates niloticus*) and bayad (*Bagrus bajad*). Studies on breeding and rearing of these fishes are ongoing in the Arab Republic of Egypt. Studies are in progress in the GCC countries (e.g. the Kingdom of Bahrain, the State of Kuwait, the Sultanate of Oman and the Kingdom of Saudi Arabia) on aquaculture potential of the higher-priced native or exotic species such as squaretail coral grouper (*Plectropomus areolatus* and *P. pessuliferus*, locally known as taradi and najil), with great promise. Research on other species, such as golden trevally (*Gnathanodon speciosus*), mangrove red snapper (*Lutjanus argentimaculatus*), snubnose pompano (*Trachinotus blochi*), spangled emperor (*Lethrinus nebulosus*), greater amberjack (*Seriola dumerili*) and cobia (*Rachycentron* canadum) is ongoing. Major research projects in the Sultanate of Oman have also been focusing on the hatchery of marine invertebrates such as abalone, mussel, sea cucumbers, oyster and shrimp culture, in addition to finfish farming. Extensive research on the culture of meagre (*Argyrosomus regius*) and European eel (*Anguilla anguilla*) is also in progress in the Arab Republic of Egypt. The Islamic Republic of Iran is starting the culture of freshwater prawn (*Macrobracum rosenbergii*), Caspian white fish (*Rutilus rutilus friisi kutum*), pike Perch (*Stizostedion lucioperca*), barbus (*Barbus sharpeyi* and *Barbus xanthopterus*) and schizothorax (*Schizothorax zarudnyi*); and studying the use of Caspian salmon (*Salmo trutta caspius*) and crayfish (*Astacus leptodactylus)*.

3.1.5 Aqua feed production

With the exception of the Arab Republic of Egypt, the Islamic Republic of Iran, the Kingdom of Saudi Arabia and probably the Republic of Iraq, the contribution of national aquafeed industries in NENA countries is almost nil. This is mainly because the small aquaculture production in these countries does not justify the establishment of aquafeed mills. The Magreb countries import most of their fish feeds from Europe (e.g. the Kingdom of Spain, the French Republic and the Hellenic Republic). The Gulf region countries import from neighbouring countries (mainly from the Kingdom of Saudi Arabia and the Islamic Republic of Iran) and from Europe.

Aquafeed production in the NENA region was estimated at about 1.55 million tonnes in 2013. About 65 percent of this production comes from the Arab Republic of Egypt (one million tonnes) (El-Sayed, Dickson and El-Naggar, 2015). The Islamic Republic of Iran comes second with a production of about 470 000 tonnes (30 percent), while the Kingdom of Saudi Arabia contributed only 4 percent (about 80 000 tonnes). Extruded (floating and sinking pellets) and compressed fish and shrimp feeds are produced in these countries, using modern technologies.

3.1.6 Aquatic animal health services

The expansion and intensification of aquaculture in NENA region, has made farmed species more vulnerable to stress and diseases. Exotic aquatic species introduced into the region may also transfer diseases to native species. Therefore, diseases of cultured species have recently been well-documented as a major problem facing aquaculture in NENA region. Both infectious and non-infectious diseases have been identified, diagnosed, and treatment/interventions suggested (El-Sayed, 2006; Aly, 2013). Yet comparatively little attention has been given to aquatic animal health management in most NENA countries. For example, the Arab Republic of Egypt does not possess a system of a coherent animal health control system for aquaculture. Regulatory provisions for quality, biosecurity, traceability and safety of farms and farmed fish products and fish feed inputs and veterinary medicines are weak or inactive. However, Law No 4/1994 prohibits the handling of hazardous substances, unless a permit has been issued by the competent body.

In the People's Democratic Republic of Algeria, the national veterinary authority is in charge of inspections of domestic and wild animals, including fish. Decree 07-208 of 2007 states that when the person in charge of an aquaculture premises notices appearance of any pathogenic agent, parasite or contaminant, that person is under the obligation to inform the veterinary authorities and the jurisdictional competent fishing administration. Decree No. 03-451 of 2003, as amended in 2010, mentions that the purchase of dangerous material and chemical products on the foreign market is subject to the grant of a prior certificate.

3.1.7 Financial services

The lack of access to credit has also been considered among the major constraints to the development of aquaculture in NENA region (FAO, 2011). Both state-owned and private banks are reluctant to finance aquaculture enterprises (Naziri, 2011) because:

1. the sector is highly risky and the banks are not prepared to carry out proper risk assessments;
2. banks require accurate feasibility studies or business plans to verify ability to achieve enough surpluses for repayment;
3. most of the small-scale fish farmers who seek credit are illiterate and often do not know how to present their projects to financial institutions and have little chance to fulfill the bank's requirements; and
4. banks ask for specific guarantees such as fixed assets, movable assets or savings certificate, which most SMEs are not able to provide.

The availability of and access to loans for investment in aquaculture are improving in some NENA countries. Gulf Cooperation Council (GCC) and Maghreb countries have begun to have easier access to loans for aquaculture expansion. The Kingdom of Saudi Arabia has eased regulations by endorsing the "Foreign Investment Law" under which investment projects can be fully-owned by foreign investors or owned jointly by Saudi and foreign investors. The Saudi Arabian Agricultural Bank provides loans (with very low interest and payable up to 25 years) to farmers for the development of aquaculture projects.

3.1.8 Aquaculture insurance

No insurance system is currently available for aquaculture enterprises in most of NENA countries, except for the Islamic Republic of Iran where almost 10 percent of aquaculture farms are under insurance coverage (Lovatelli, personal communication, November 2016). This may be due to the relatively short history of aquaculture and the perception of insurance companies that aquaculture is a risky business. An insurance system would significantly promote the development of this sector, by ensuring more stable incomes and increasing investment incentives. This instrument would also improve access to formal credit, by reducing the risk of non-payment of loans (Naziri, 2011).

In some other cases, traders in the Arab Republic of Egypt offer farmers credit for the purchase of their fish after harvest. The contract between the farmer and the trader generally entails the sale of the fish at an agreed price. This price is generally lower than the market price at harvest time, which leaves the farmer at a disadvantage and may cause economic loss.

3.1.9 Harvest and postharvest services

The market price usually determines the harvesting time particularly for some of the lesser valued species such as tilapia. Some farmers adopt partial harvesting by removing large fish to provide smaller fish with more space for growth. Harvesting methods depend on farmed species, culture systems, pond size and shape, and levels of technology applied. Complete pond draining and netting of fish are the most common harvesting methods. Most small-scale farmers harvest their crops by themselves, while large farmers generally depend on seasonal labourers for harvesting tilapia crops.

Fish are marketed fresh, iced or frozen. There is also a growing preference for live fish. Some aquaculture companies also process their products to increase the value added.

3.2 Issues

Land availability for inland aquaculture in the NENA region is a serious constraint. Coastal lands are also allocated to other activities such as industry, tourism and housing. Despite the fact that many NENA countries are self-sufficient in freshwater seed supply, produced seed is often of poor quality and poorly handled and transported. Inappropriate hatchery installations and management are also common. In the case of marine seed, there is a wide gap between seed production and farmer demand. Most NENA countries also import their feed ingredients or processed fish feeds from abroad at high prices. NENA countries also do not possess animal health control systems for aquaculture. Specialized labs, consultants and clinics for fish disease inspection and treatment remain scarce. Regulatory provisions for quality, biosecurity, traceability and safety of farms and farmed fish are lacking, weak or inactive. The access to credit, loans and insurance for aquaculture business is almost nonexistent in most of the NENA countries.

3.3 Success stories

The development of the aqua feed industry in the Arab Republic of Egypt is a success story in the NENA region. The Arab Republic of Egypt is currently among the top aquafeed producers in the world and its commercial aquafeed industry has witnessed a substantial development in the past 15 years. The number of feed mills increased from five state-owned mills producing 20 000 tonnes in 1999 to over 60 mills with a production of about one million tonnes in 2013 in the form of compressed and extruded feeds (El-Sayed, Dickson and El-Naggar, 2015). About 90 percent is produced by the private sector. Since the early 2000s, a number of private fish feed manufacturers have added production lines for extruded feed production to their traditional production lines, because he market demand for extruded feed is increasing.

3.4 The way forward

Countries in the NENA region must increase the efficiency of their water usage and ensure higher returns per volume of water used. They also need to adopt alternative practices, such as the re-use of waste water. New water usage policies should also be developed for more control of water use in crop production, especially to reduce drainage water, which can be devoted to aquaculture. More attention should also be directed towards the development of marine aquaculture.

Improving the quality and availability of fish seed for aquaculture will require extension services particularly to small-scale hatcheries, improved broodstock and seed and appropriate feeds and feeding strategies, and training of hatchery managers in hatchery operations and management. Similarly, efforts should be made to reduce feed costs and improve feed quality and efficiency. There is also an urgent need for increased aquatic animal health capacity to support aquaculture development and sustainability in the region.

4. AQUACULTURE AND ENVIRONMENTAL INTEGRITY

The expansion of aquaculture in the NENA countries, together with intensive use of artificial culture inputs such as processed feed, drugs, hormones, fuels, etc., may pose environmental and socioeconomic threats. Intensive aquaculture may lead to enrichment of aquatic environments. For example, Kürten *et al.* (2015) reported that effluent from the aquaculture facility at Al-Lith in the Red Sea, the Kingdom of Saudi Arabia, has increased the organic matter in the form of particulate organic carbon (POC) and particulate nitrogen (PN) in the adjacent reef areas, leading to eutrophication. This in turn has led to toxic algal bloom in the area.

The following section sheds some light on the environmental effects of aquaculture in NENA region.

4.1 Environmental impacts of aquaculture

4.1.1 Water pollution

The northern Nile Delta lagoons and agricultural drains in the Arab Republic of Egypt receive great amounts of industrial, municipal and agricultural wastewater, leached fertilizers, herbicides, pesticides and sewage effluent (Oczkowski *et al.*, 2009). Fish farmed in these brackishwater sources will very likely be contaminated with organic and inorganic pollutants. Under these unfavourable conditions, these fish will be contaminated and become vulnerable to stress and diseases, which may affect their quality and pose high human health risk.

4.1.2 Environmental impacts of cage culture

The wide spread of cage culture in NENA countries (especially tilapia culture in the Arab Republic of Egypt) may cause negative ecological impacts resulting from the accumulation of fish faeces and feed wastes from the cages on the bottom. The oxidation of this organic matter leads to oxygen depletion, increased ammonia and hydrogen sulphide concentrations, creating anoxic condition. Such an effect is very evident in Rosetta and Damietta branches of the Nile River, where cage culture is widely practiced. Efforts are being made in the region to ensure that marine cage aquaculture is developed sustainably, and many countries (e.g. the Kingdom of Saudi Arabia) have issued regulations to ensure that farming facilities are properly sited and have enacted strict and clear environmental monitoring guidelines.

4.1.3 Effects of steroid hormone 17-α methyltestosterone residues

The culture of monosex (all-male) Nile tilapia is expanding in NENA region, especially in the Arab Republic of Egypt. All-male seed is produced using oral administration of 17α-methyltestosterone

(MT) in larval feeds. The hormone residues and metabolites can be a potential environmental contaminant, and may pose human health risk. As a result, the use of hormones for sex reversal of tilapia has been under increasing public criticism. Many countries have banned the use of this hormone in fish sex reversal; however, it is still widely used illegally.

4.1.4 Overfishing of marine fish seed

As mentioned in Section 3.1.3.2, seed of marine species, especially mullets, seabream, seabass, eel and meagre, is collected from the wild, leading to massive overfishing of these species. It is very likely that the continuation of overfishing of marine seed for aquaculture will lead to dramatic declines in their natural stocks. This practice is however limited to some countries with the Arab Republic of Egypt in the lead.

4.1.5 Impacts of introduced and invasive species

Several exotic species, including carps, sturgeons (*Acipenser* spp.), barramundi (*Lates calcarifer*) and many others (e.g. gilthead seabream in the Arab Gulf and Red Sea), have been introduced into NENA countries, for various reasons, but mainly for aquaculture. These species may pose risks to local habitats, including pathogen introduction and escape into the wild, causing genetic pollution and/or habitat destruction and potential ecosystem effects that could cause decline or disappearance of native species.

The introduction of red swamp crayfish (*Procambarus clarkii*) into the Arab Republic of Egypt is a striking example of the destructive effect of introduced species. This species was introduced accidentally into the Arab Republic of Egypt in mid-1980s, and was able to grow and reproduce efficiently in the wild. The species invaded the Nile River and its tributaries and northern coastal lagoons, causing serious environmental damage including destroying the banks and dykes of the Nile River and the irrigation canals which are important feeding and spawning grounds for many fish species. Crayfish also prey upon fish eggs, larvae and fingerlings, eat trapped fish and destroy trap nets.

4.2 Issues

The expansion of the aquaculture industry in the NENA region has increased environmental concerns more so in those countries like the Arab Republic of Egypt where the industry is rather large. Public awareness has also been growing about food security issues and environmental conservation. Therefore, environmental impact assessments (EIA) are required for aquaculture projects. Capacity-building workshops and training courses on sustainable, socially acceptable and environmentally friendly aquaculture are taking place in the region, supported by the relevant authorities and national and international developmental agencies (FAO, 2011). However, environmental issues are not well-covered in aquaculture and fisheries legislation.

4.3 The way forward

The following courses of action should be adopted in order to reduce environmental impacts of aquaculture practices in NENA region:

1. **Management of introductions and transfers.** It is essential that firm regulations be put in place to control the introductions and/or transfers of aquatic species. Necessary precautions should also be taken before any introductions take place (FAO, 1995).
2. **Management of effluent and nutrient loading.** NENA countries should adopt the best management practices (BMPs) to minimize nutrient loads from aquaculture effluents. Increasing water use efficiency by adopting integrated agriculture-aquaculture will also help reduce the amount of loaded aquaculture effluent entering the environment.

3. **Improvement of aquaculture legislation**. Relevant laws, decrees and governing regulations in many instances need to be reviewed and/or amended, with emphasis on the articles related to environmental management and protection.
4. **Environmental Impact assessment (EIA).** Adequate EIAs for all aquaculture projects should be thoroughly carried out and approved by decision makers before any aquaculture licenses be issued.

5. MARKETS AND TRADE

5.1 Status and trends

5.1.1 Main markets and trade characteristics

Farmed and wild caught fish and shellfish are generally marketed together in the retail market, but there is a general misconception among consumers about the quality of farmed fish. Consumers believe that farmed fishes are inferior in quality to wild caught fish; however, they are unable to differentiate between farmed and wild caught fish (Sprague, Dick and Tocher, 2016). There are currently no regulations in NENA countries requiring the origin of fish products whether farmed or captured fish.

Aquaculture products are traditionally consumed fresh, mostly whole and in unprocessed form without any value addition (e.g. tilapia marketing in the Arab Republic of Egypt). The main market segments are: 1) the retail sector, which is the main market segment for fish sales and is generally made up of independent retailers and street vendors; 2) multiple retailers, such as hypermarkets, supermarkets, restaurants and fish fryers/grillers; and 3) live fish marketing, which is growing in a number of NENA countries.

5.1.2 Traders and wholesalers

The wholesale fish markets in most NENA countries are controlled by a few large traders/wholesalers who determine the market prices, mainly according to supply and demand. Most fish farmers sell their products to these wholesalers. However, some small farmers (e.g. in the Arab Republic of Egypt) sell their fish to retailers and sometimes directly to the consumers (Macfadyen *et al.*, 2011). Specialized fish markets are also distributed in the major cities and towns throughout the region, where fish auctions and marketing take place.

5.1.3 Export and import of fish and fishery products

5.1.3.1 Export

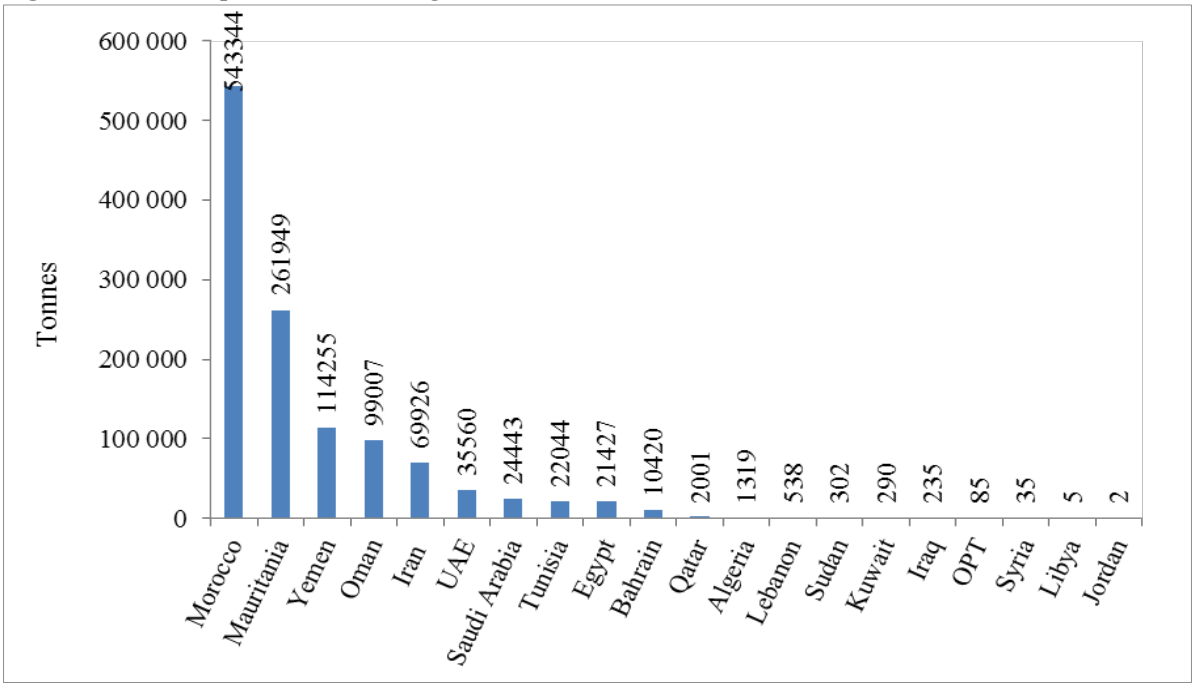
Total exports of fish and fishery products represented 26.7 percent of the total regional production in 2013. The Kingdom of Morocco alone exports most of the region's fish exports, contributing 45 percent to total export, followed by the Islamic Republic of Mauritania (21.7 percent), the Republic of Yemen (9.5 percent) and the Sultanate of Oman (8.2 percent) (Figure 11). The rest of the region's countries represented only 15.6 percent of total fish export in 2013. The majority of exports are mainly in the form of whole, chilled products and partially processed products (e.g. canned sardines in the Kingdom of Morocco and gutted tuna in the Sultanate of Oman). The majority of exported fish and fishery products were destined for the markets of the European Union (EU), Near East and North Africa region and some to East and Southeast Asia.

5.1.3.2 Import

The NENA region imports substantial quantities of fish and fish products annually to cover the gap between local production and consumption. The imports totalled 1 113 940 tonnes in 2013,

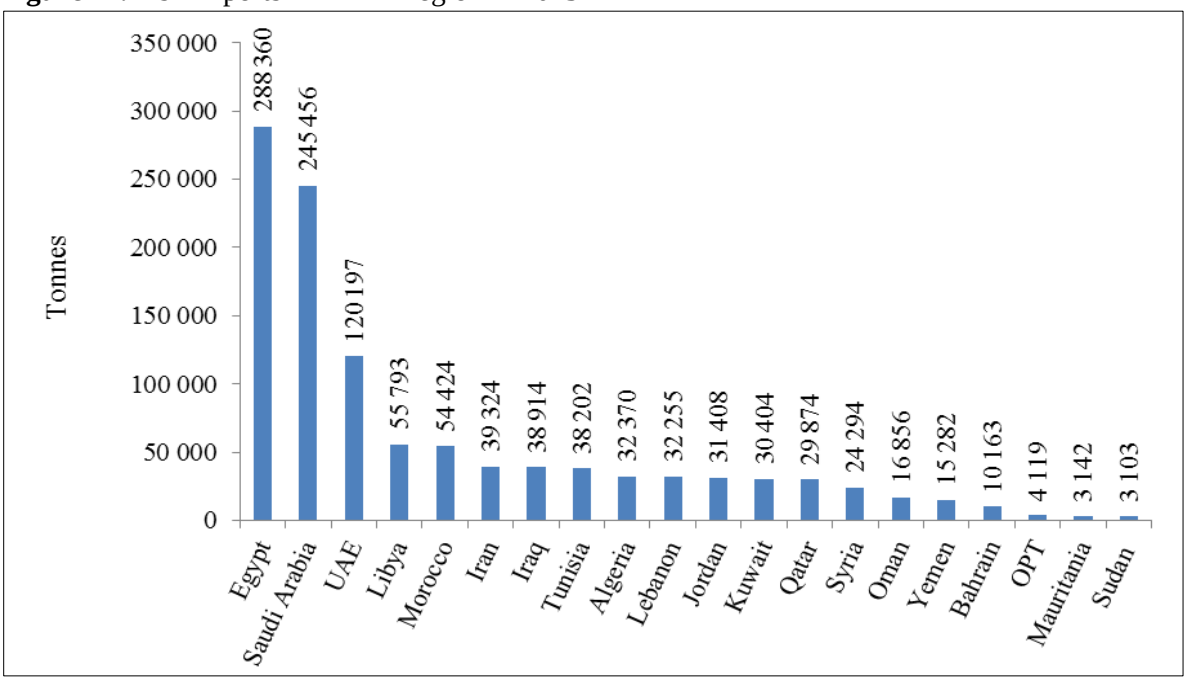
representing 24.7 percent of total production. The Arab Republic of Egypt is, by far, the largest fish importer in the region, with an import of 26 percent of total import in 2013, followed by the Kingdom of Saudi Arabia (22 percent) (Figure 12). Most imported fish and fishery products come from the European Union, the Near East and North Africa region, East and Southeast Asia, South America and Southern Asia. Frozen fish and fish products are the main forms of imported fishery products.

Figure 11. Fish exports in NENA region in 2013



Source: FAO, 2016. www.fao.org/fishery/statistics/global-commodities-production/query/en

Figure 12. Fish imports in NENA region in 2013



Source: FAO, 2016. www.fao.org/fishery/statistics/global-commodities-production/query/en

5.1.4 Potential for increased demand for aquaculture products

As indicated from fish production, export and import data in the NENA region, it is clear that there is a gap between production and consumption. The increased human population, stable capture fish production and limited aquaculture contribution (except in the Arab Republic of Egypt and the Islamic Republic of Iran) may widen this gap. This means that the demand for aquaculture products in the region will increase; and the aquaculture sub-sector will likely expand much further. In support, a recent study on the global role and opportunity for aquaculture to 2030, Kobayashi *et al.* (2015) projected that the aquaculture sector in the Middle East and North Africa is expected to grow 76 percent during the period 2010–2030. These projections are in line with recent aquaculture research and development efforts in the region. There is also a potential for further increases in per capita fish consumption, especially when different fish products become available and at competitive prices.

5.2 Issues

Several major issues have been identified in aquaculture markets and marketing in the NENA region. In addition to the general negative consumer perceptions about farmed fish, there is limited information on fish marketing, a lack of fish market promotional strategies, and a market monopoly by a few fish traders. A value chain analysis of aquaculture markets and marketing, including fish harvesting, handling and transport, traders and wholesalers, retailers and trade is lacking in most of the NENA countries. Competition is also an important issue. The import of cheap (and occasionally low-quality) fish products may threaten the local aquaculture market. For example, the import of large quantities of *Pangasius* catfish fillets from Viet Nam during the past few years at very low prices has adversely affected local fish marketing (especially of tilapia) in the Arab Republic of Egypt.

5.3 The way forward

Awareness campaigns to change consumers' negative perception about farmed fish and to increase demand for farmed fish should be initiated. Better marking/labelling, and potentially even branding, of locally produced farmed fish in local markets will allow consumers to easily differentiate between farmed and imported fish products. Countries like the Kingdom of Saudi Arabia has started doing so with farmed barramundi and shrimp. The aquaculture sector should also be qualified for export through adoption of a reform process aimed at converting the conventional aquaculture sector into a market-oriented, internationally competitive business. Further developing of value added farmed fish products should also receive increase attention by the sector. The value chain of aquaculture market and marketing, including fish harvesting, handling and transport, traders and wholesalers, retailers and trade should be analyzed.

6. CONTRIBUTION OF AQUACULTURE TO FOOD SECURITY, SOCIAL AND ECONOMIC DEVELOPMENT

6.1 Status and trends

Aquaculture provides a significant contribution to improving the socio-economic status of target communities through: contributing to local, national and regional economies, generating employment, especially in rural and marginal households, and promoting food security and poverty alleviation.

6.1.1 Contribution of aquaculture to local, national and regional economies

The contribution of aquaculture to the GDP in the NENA region remains insignificant. Moreover, in most countries the whole fishery sector is generally not considered an independent economic sector *per se*, nor assessed as a special component in the national economy. Despite the significant

development in aquaculture sector in the region during the past 10 years, the percent contribution of aquaculture to national economies in 2014 was not different from that of 2007.

6.1.2 Employment

Aquaculture in most NENA countries is a small-scale practice, depending mainly on family labour, with limited external employment. Employment is generally seasonal, mainly during stocking and harvesting. Commercial, large-scale aquaculture farms employ skilled managers, technicians and labour on both a long-term and short-term basis. Associated economic activities and services have also been created; including hatcheries, feed mills and manufacturing of farming facilities and equipment, research, monitoring and extension, pond construction and maintenance, seed production and distribution, fish transport, marketing, processing and other support activities.

The number of workers engaged in aquaculture in NENA region varies considerably from one country to another, ranging from few to hundreds of thousands. In the Arab Republic of Egypt, Macfadyen *et al.* (2011) reported that the total number of full-time workers engaged in pond fish farming in the Arab Republic of Egypt in 2011 was 81 906 people, while the total number employed in the aquaculture value chain was 136 181. The number of workers in fish hatcheries, cage farms, and intensive pond and tank aquaculture was about 25 000. In addition, there are 1 500–2 100 full-time jobs in feed mills (both state-owned and private mills), while the number of part-time jobs is about 4 500 (A.-F.M. El-Sayed, personal survey, 2013).

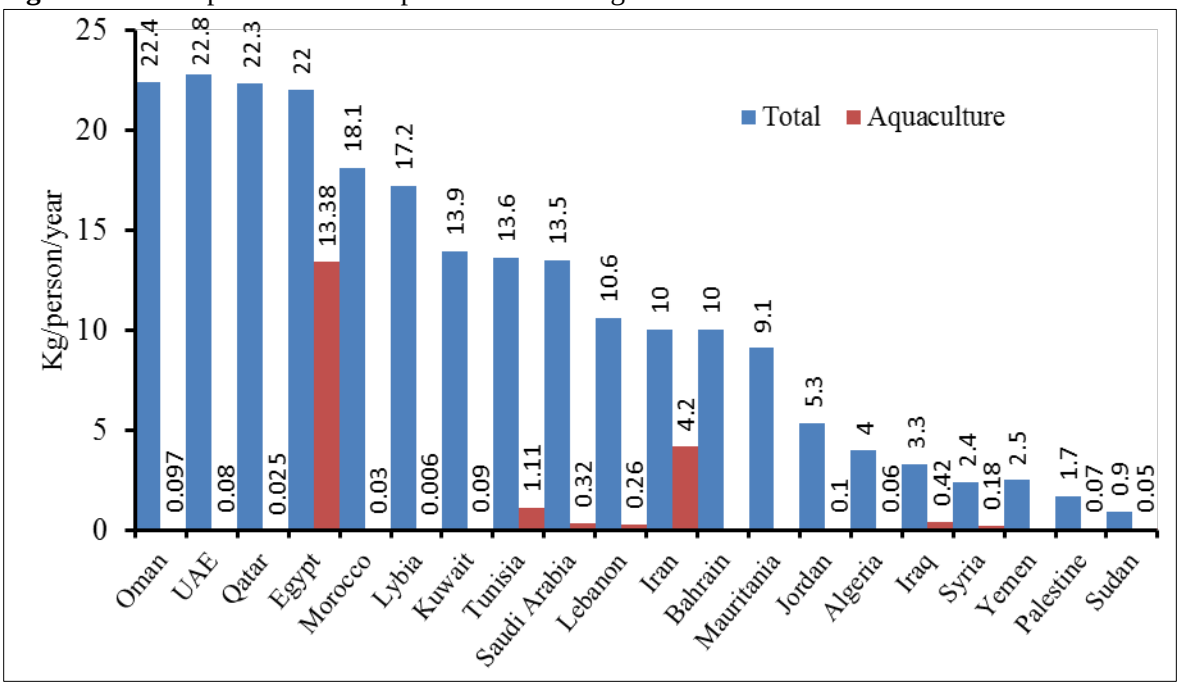
In the Islamic Republic of Iran, the total number of people directly employed in aquaculture and aquaculture-based fisheries is 68 287 (see FAO NASO Iran (Islamic Republic of)). Shrimp culture created about 8 896 direct, full-time jobs in farms and hatcheries and almost an equal number of indirect, full-time jobs in feed production, processing units, trade, distribution and support services along the southern coast of the country. The number of part-time jobs created in related sectors such as construction, transport, equipment services, etc., has also been significant. Filled aquaculture positions in the other NENA countries for which there are data include 2 690 in the Republic of Iraq, 110 in the State of Kuwait, 3 407 in the Kingdom of Saudi Arabia (in 2003) and 1 000 in the Republic of Tunisia[2].

6.1.3 Improving livelihoods and per capita fish consumption

Commercial aquaculture can greatly improve livelihoods, mainly by generating employment opportunities through the value chain and through the provision of quality animal protein source. The average per capita fish consumption increased from 9.65 kg/year in 2005 to 11.3 kg/year in 2013. However, this average remains lower than the average global per capita consumption (19.7 kg/year). Only four NENA countries (the Sultanate of Oman, United Arab Emirates, the State of Qatar and the Arab Republic of Egypt) exceeded the world average (Figure 13). Eight countries (the Kingdom of Bahrain, the Islamic Republic of Iran, the State of Kuwait, the Lebanese Republic, Libya, the Islamic Republic of Mauritania, the Kingdom of Morocco, the Kingdom of Saudi Arabia and the Republic of Tunisia) consumed >10 kg/person/year, while per capita fish consumption in the rest of the region's countries was <10 kg/year in 2013[3]. The contribution of aquaculture to fish consumption in the region is insignificant, except in the Arab Republic of Egypt and the Islamic Republic of Iran, which represented 61 and 42 percent, respectively, of total per capita fish consumption in 2013 (Figure 13).

[2] www.fao.org/fishery/naso/search/en
[3] www.fao.org/fishery/static/Yearbook/YB2014_CD_Master/root/food_balance/section1.pdf

Figure 13. Per capita fish consumption in NENA region in 2013



Source: FAO, www.fao.org/fishery/static/Yearbook/YB2014_CD_Master/root/food_balance/section1.pdf
Note: Aquaculture consumption was calculated by the author by dividing aquaculture production by country's population.

6.2 Issues

The contribution of aquaculture to national economies and job creation in the NENA countries is still limited. Sector organizations, including fish farmers' associations, are not very active, and play a limited role in providing assistance and services to the sector. No aquaculture insurance or credit systems are available in most NENA countries in support of the industry.

6.3 The way forward

The NENA countries should start rehabilitation programmes for capacity-building and institutional development of these associations and NGOs. Fish farmers in NENA region should also be encouraged to establish more associations. the Kingdom of Saudi Arabia recently established the Saudi Aquaculture Society (SAS). Substantial efforts should be made to increase employment opportunities. The generation of additional employment in all subsectors of the aquaculture value chain could occur through expansion of aquaculture into new areas and dimensions, increasing intensity of production for the existing farms through the adoption of modern technologies and BMPs, and developing post-harvest processing and increasing the added value of aquaculture products. NENA countries should establish insurance, funding and financing sources for the aquaculture sector.

7. EXTERNAL PRESSURES ON THE AQUACULTURE SECTOR

7.1 Status and trends

The aquaculture sector in general is fragile in the NENA region, and highly sensitive to environmental conditions. In addition, economic, social and financial conditions and crises directly or indirectly affect the sector, especially when the availability of major inputs (such as feed, seeds and energy) is insufficient, or when their prices are affected. The Arab Republic of Egypt, for example, imports 50–90 percent of the feed ingredients used for fish feed production. The continuous global increase in the prices of these of feed ingredients in recent years has resulted in a sharp increase in fish feed prices

in the country, leading to severe reduction in profit margins. Many fish farmers (especially small farmers) in the Arab Republic of Egypt are now struggling to survive and a few have abandoned the business.

7.1.1 Effects of climate changes

One of the greatest challenges facing aquaculture development in NENA region is the unpredictable impact of climate changes. The climate changes in the region present severe threats of changes in temperature, weather and water supply. Climate changes modify the distribution and productivity of marine and freshwater species and, in turn, affect reproductive and biological processes and alter food webs (Pullin and White, 2011).

The implications of climate change for food security and livelihoods are profound. Throughout the NENA region, especially in the Arab Republic of Egypt, fishers, fish farmers and coastal inhabitants will be most affected. The northern Nile Delta belt of the Arab Republic of Egypt is about 1–3 m below sea level, with coastal lagoons falling within this belt. The sea level rise caused by global warming will threaten the existence of these areas. The potential impact of climate change on the northern Delta belt and coastal lagoons, where aquaculture activities are clustered, is evident. Migration routes, timing and behaviour of migratory fishes inhabiting these lagoons may also be adversely affected by climate change. Coastal fish ponds may also be prone to flooding, water quality changes, and saline intrusions.

There have been occasional mass mortalities of farmed and wild fishes in the Arab Republic of Egypt and Gulf countries (e.g. the Sultanate of Oman and United Arab Emirates) due to unexpected high water and air temperatures, oxygen depletion or harmful algal blooms (HABs) (Glibert *et al.*, 2002). Adverse effects of exceptionally high or low water temperature on wild and/or farmed fish have also been recorded in the Syrian Arab Republic (FAO, 2011). Early spring warming hampered trout spawning, leading to abandoning trout farming in the Syrian Arab Republic. Cold spells have also caused problems for tilapia producers in the Arab Republic of Egypt and the Syrian Arab Republic.

7.1.2 Impacts of other natural, economic and political factors

Military conflicts, civil wars and political instability limit the development of agricultural sectors, including aquaculture, in Libya, the Republic of Iraq, Palestine, the Republic of Sudan, the Syrian Arab Republic, and the Republic of Yemen. Such political problems also threaten the economic viability of aquaculture enterprises and security of investment. Consequently, aquaculture production in Libya, the Syrian Arab Republic and the Republic of Yemen was drastically reduced between 2005 and 2014.

Natural disasters have become more frequent and increasingly destructive during the last few decades. Communities depending on fisheries and aquaculture for their livelihoods are threatened both by natural hazards and human-induced disasters (Westlund *et al.*, 2007). NENA region is characterized by heavy maritime transport, especially in the Mediterranean Sea and the Gulf. It is also an important centre for oil production, refining and transportation. Coastal aquaculture in NENA region is, therefore, constantly at risk from disasters such as oil spills.

Outbreaks of disease and other threats to farmed fish can cause large production losses. A massive fish kill in Kuwait Bay, caused by bacterial disease, harmful algae and eutrophication, was recorded in 2001 (Glibert *et al.*, 2002). Richlen *et al.* (2010) reported a severe and widespread harmful algal bloom (HAB) caused by the marine dinoflagellate *Cochlodinium polykrikoides* in the Gulf and Gulf of Oman. That HAB has lasted for more than eight months, killing thousands of tons of fish, and limiting traditional fishery operations, damaging coral reefs, impacting coastal tourism, and forcing the closure of desalination plants in the region.

7.2 Issues

One of the major constraints facing aquaculture development in NENA region is the unpredictable and uncharacterized impact of climate changes. National preparedness plans for facing climate changes and disasters and mitigation and adaptation strategies are lacking. Any assessment of disaster impact before and during the immediate relief efforts is generally ignored by the authorities in charge. There is a research gap on the effects of external pressures on aquaculture and fisheries sectors.

7.3 The way forward

Preparedness to mitigate and adapt to the negative effects of climate change, natural disasters and drought is essential, and national and regional strategies need to be elaborated. Such strategies should be regularly evaluated, revised and improved.

Characteristics of the fisheries (artisanal, industrial, fishing methods, marine fisheries, freshwater, fisheries, etc.) and aquaculture (subsistence, commercial, farming systems, species farmed, culture inputs) sector and the livelihood context of small-scale fishers and fish farmers need to be clearly understood. This would enable authorities to provide adequate disaster response to help these people to be better prepared for and warned of potential future threats. Appropriate water-saving production systems and technologies (e.g. integrated aquaculture in the desert and arid lands) should be adopted, in order to use the already-scarce water resources more efficiently.

8. GOVERNANCE AND MANAGEMENT OF THE SECTOR

8.1 Status and trends

8.1.1 Aquaculture management authorities: their policies, strategies and legislation

As stated by FAO (2011), there are three main models for the national management of aquaculture sectors in the Near East and North Africa region:

1. by a specialized unit (ministry branch, department or division), typically under the Ministry of Agriculture (e.g. the Hashemite Kingdom of Jordan, the State of Kuwait, the Lebanese Republic, Palestine, the State of Qatar, the Kingdom of Saudi Arabia, the Syrian Arab Republic, and the United Arab Emirates);
2. by an independent entity (authority, commission, institute or bureau) that may or may not belong to the Ministry of Agriculture (e.g. the Kingdom of Bahrain, the Arab Republic of Egypt, the Republic of Iraq, the Islamic Republic of Iran, the Kingdom of Morocco, Libya, the Sultanate of Oman and the Republic of Tunisia); or
3. by a Ministry of Fisheries or Marine Resources (e.g. the People's Democratic Republic of Algeria, the Islamic Republic of Mauritania, the Republic of Sudan and the Republic of Yemen).

Almost all national aquaculture policies in the region share the same common goals (FAO, 2011); these include increasing sustainable aquaculture output, promoting national economies and supporting national export opportunities.

National aquaculture legislation and developmental strategies have been drafted and adopted mainly by those NENA countries whose aquaculture sectors have a long history and play a significant role in domestic fish supply, namely the Arab Republic of Egypt and the Islamic Republic of Iran. The aquaculture policies and strategies of the major producers in the region are reviewed below, with emphasis on the Arab Republic of Egypt and the Islamic Republic of Iran, since together they produce 95 percent of total aquaculture output in the region. Aquaculture Strategies and Plans of Action are starting to be drafted or putted in place in many countries of the region as the People's Democratic Republic of Algeria, the Islamic Republic of Mauritania, the Kingdom of Morocco, the Lebanese

Republic, Libya, the Sultanate of Oman, the Republic of Tunisia, the State of Qatar, the Kingdom of Saudi Arabia and United Arab Emirates.

8.1.2 Aquaculture and fisheries legislation in the Arab Republic of Egypt

Aquaculture and fisheries legislation in the Arab Republic of Egypt includes acts, decrees and governing regulations for access to land and water, fish movements, environmental impact assessments, drugs and lease terms.

Act No. 124/1983 is the main body of legislation regulating fisheries, fishing, aquatic life and aquaculture. The act contains a number of articles related to fisheries and the aquaculture industry. This law requires licensing of aquaculture activities by the General Authority for Fish Resources Development (GAFRD). The act also specifies the conditions required for obtaining a licence. The GAFRD is responsible for the administration and enforcement of Act No. 124/1983.

Changes to legislation subsequent to the most recent review of aquaculture in NENA countries (FAO, 2011) include:

Decision No. 592/2012 (amendment of Decision No. 321/2012) regulates the collection and/or fishing of marine fish seeds for aquaculture needs. The new amendment added more conditions and restrictions on fishing times, fishing authorization and supervision by GAFRD.

Decision No. 831/2013 specifies the renewal of the lease contracts for 25 years. The decision states that the lease contract for fish farms and fish hatcheries on State-owned lands is five years, and that it may be renewed for one or more terms for a maximum of 25 years upon the authorization of the authorized minister and the approval of GAFRD.

8.1.3 Aquaculture and fisheries legislation in Islamic Republic of Iran

The management of fisheries and aquaculture activities in the Islamic Republic of Iran is based on the provisions of the Law Concerning the Exploitation and Protection of Aquatic Resources (1976), and the Law of Protection and Exploitation of Fisheries Resources (1995). The Iranian Fisheries Authority (Shilat) is the main organization responsible for fisheries and aquaculture management. Shilat is established under the Establishment Act of Iranian Fisheries Organization (2004), and is affiliated to the Ministry of jihad Agriculture. It is in charge of protection and rehabilitation of existing fish resource, improvement of habitats and stocking of Iranian marine and inland waters. It is also responsible for development of aquaculture, through research, training and promoting technical services. Shilat is furthermore tasked to adopt regulations for the implementation of the 1995 Law in coordination with the Department of Environment. The following four government departments are also involved in aquaculture management: the Department of the Environment, the Veterinary Organization, the Department of Natural Resources and the Department of Water Resources (Ministry of Energy).

8.1.4 Aquaculture and fisheries legislation in other NENA countries

In the Kingdom of Saudi Arabia, the main agency tasked to regulate and supervise aquaculture development is the Department of Aquaculture (DA), under the Office of the Deputy Ministry of Fisheries Affairs within the Ministry of Agriculture (MOA). The DA supervises site selection for aquaculture projects, revises aquaculture plans, analyzes aquaculture market and applies the principles and practices of aquaculture biosecurity.

In the Republic of Iraq, the General Board for Fish Resource Development is the main authority responsible for regulating and supervising fishery and aquaculture sectors, through an effective regulatory framework for both inland and marine fisheries and aquaculture. Law No. 48 of 1976 regulates all fisheries and aquaculture activities. However, the enforcement of Iraqi aquaculture regulations is currently weak, mainly due to the change of governments and political instability.

In the Syrian Arab Republic, the Department of Fisheries Resources (DoF), established in 1986 within the Ministry of Agriculture and Agrarian Reform (MAAR), governs the fisheries and aquaculture sector. The Environment Protection Law focuses on the protection of the environment in general, including the aquatic environment.

In the People's Democratic Republic of Algeria, the main aquaculture legislation is Law No.01-11 of 2001, relating to Fisheries and Aquaculture. The Law defines the general rules of the management and development of fishing and aquaculture. The Law also promotes the development of fisheries and aquaculture activities and provides for state support through a national framework that includes a national chamber of fisheries and aquaculture, a national consultative council for fisheries and aquaculture and a national research centre of fisheries and aquaculture.

In the Kingdom of Morocco, the National Agency for Aquaculture Development (Agence Nationale pour le développement de l'aquaculture – ANDA), is responsible for supporting the development of the sector and guides national development goals.

In the Republic of Tunisia, the Ministry of Agriculture and Water Resources is responsible for aquaculture through the Secretary of State for Fisheries and the Directorate-General for Fisheries and Aquaculture (Aquaculture Sub-Directorate). The Aquaculture Sub-Directorate has only one service responsible for marine aquaculture. Health monitoring and control is the responsibility of the Directorate-General for Veterinary Services, under the supervision of the Ministry of Agriculture and Water Resources. Monitoring the environmental impact of aquaculture projects and environmental protection is carried out by the National Agency for Environmental Protection. The issue of permits is done by the Interdepartmental Advisory Commission under the Presidency of the Directorate-General for Fisheries and Aquaculture. There have been no new aquaculture-related Acts or Decrees in the Republic of Tunisia since 1994.

8.2 Issues

Several gaps in governance and management of aquaculture sector in the NENA regions have been identified. In many countries, governance and regulation of the sector is generally carried out by more than one authority. Conflict of interest sometimes arises among these authorities, leading to poor management strategies and policies. Fisheries and aquaculture legislation in some NENA countries may contain some overlaps. In many cases specific laws and regulations seem to be outdated, and do not reflect the recent concepts and approaches developed for responsible and sustainable aquaculture management or meet the needs of the sector.

Regulatory provisions for quality, biosecurity, traceability and safety of farms and farmed fish products and fish feed inputs are weak and inactive in almost all NENA countries. Most NENA countries do not have comprehensive regulatory and quality control systems that address fish quality control inspections and human food safety hazards in animal feeds (including fish feed). No animal health control system for aquaculture is available, exposing the sector to potential disease risks. Fish farmers' associations and unions are generally weak, and in some cases do not exist.

8.3 The way forward

The government of NENA countries should put more effort into change, activation, amendment and enforcement of fisheries and aquaculture legislation. Legislation should be issued and regularly reviewed by NENA governments to guarantee the quality, biosecurity, traceability and safety of farmed and fish products and fish feeds. Legislation regulating the use of veterinary medicines in aquaculture should also be addressed in the development of the regulatory framework for aquaculture. A participatory approach should also be adopted in national aquaculture development policies in NENA countries. Major stakeholders should be involved in the management of the sector.

9. AQUACULTURE CONTRIBUTION TO FAO STRATEGIC OBJECTIVES

9.1 Sustainable Development Goals and Blue Growth Initiative

On 25 September 2015, the United Nations adopted the 17 Sustainable Development Goals (SDGs) of the 2030 Agenda for Sustainable Development[4]. The SDGs will shape national development plans over the next 15 years (2016–2030). Sustainable food and agriculture ending poverty and hunger, responding to climate change and sustaining natural resources are the core of the 2030 Agenda (FAO, 2016b).

In order to help achieve the SDGs, FAO and its members and partners have been mainstreaming the Blue Growth Initiative (BGI). BGI is the sustainable growth and development emanating from economic activities in the oceans, wetlands and coastal zones. BGI minimizes environmental degradation, biodiversity loss and unsustainable use of living aquatic resources, and maximizes economic and social benefits. BGI is composed of four major components: marine and inland capture fisheries, aquaculture, livelihoods and foods systems, and economic growth from ecosystem services (Mathiesen, 2015).

Aquaculture contributes to blue growth of national economies through more efficient and sustainable use of aquaculture resources. The main objectives of the initiative[5] are:

1. improving the utilization efficiency to aquaculture resources;
2. improving production efficiency with reduced impacts on the environment;
3. increasing the resilience of farmers and the sector;
4. increasing the efficiency of aquaculture value chains, and improving the equity and social acceptability along the value chain;
5. minimizing environmental degradation, biodiversity loss and reducing aquatic animal disease risks; and
6. improving livelihoods and better securing food systems.

9.2 Aquaculture contribution to SDGs and BGI in the NENA region

In the NENA region, aquaculture and fisheries represent a considerable component of food security and national income in a few countries (the Arab Republic of Egypt, Islamic Republic of Iran and the Kingdom of Morocco). However, the role of aquaculture in the rest of the NENA countries remains insignificant. The sector is also facing many challenges that limit its development. These include: farmers' adaptability to climate change and resilience to natural disasters and socioeconomic risks, environmental and social impacts of aquaculture, access of fish farmers to quality production inputs and technologies and improving governance and management of aquaculture sector.

Until recently, most NENA countries had not created strong and meaningful partnerships with the FAO global BGI in order to face these challenges. In order to tackles these issues; the BGI has recently been mainstreamed across the NENA region. A comprehensive study is under way with a view to promote the potential of blue growth in the region. Activities that have been targeted include: a) promoting desert aquaculture in the People's Democratic Republic of Algeria; b) assessing livelihoods of fishing communities along the Nile River in the Arab Republic of Egypt and the Republic of Sudan (FAO, 2016c); c) sustainable integrated management of aquaculture, capture fisheries and the environment in the People's Democratic Republic of Algeria, the Arab Republic of Egypt, the Kingdom of Morocco and the Republic of Tunisia (Cataudella, Crosetti and Massa, 2015); d) improving value chains in the Republic of Tunisia to ensure that women harvesting clams receive greater and diversified income; and e) promoting the Nouakchott Declaration on the reduction of losses and waste in the fisheries sector (FAO, 2016c).

[4] www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E
[5] *Source:* FAO, www.fao.org/3/a-mk541e/mk541e02.pdf and www.fao.org/asiapacific/perspectives/blue-growth/en/

In addition, several training courses and workshops were held on different aquaculture development issues. For example, FAO convened a training workshop on aquaponics for countries in the NENA region. Another training workshop for transport of live aquatic animals and biosecurity in aquaculture in the region was held in Muscat, the Sultanate of Oman in 2015. It covered several subjects, including risk analysis of transporting live aquatic animals, biosecurity programmes and updating the regional aquatic animal health programmes.

At present, the General Fisheries Commission for the Mediterranean (GFCM) is implementing several regional marine capture fisheries and aquaculture projects, including:

1. indicators for Sustainable Development of Aquaculture and Guidelines for their use in the Mediterranean – InDAM;
2. development of site selection and carrying capacity guidelines for Mediterranean aquaculture within aquaculture appropriate areas – SHoCMed; and
3. Mediterranean coastal lagoons management: interactions between aquaculture and marine capture fisheries – LaMed (component 2).

These projects build upon results achieved in the Mediterranean countries, including North African countries (the People's Democratic Republic of Algeria, the Arab Republic of Egypt, Libya, the Kingdom of Morocco and the Republic of Tunisia). These work programmes will focus on improving site selection for aquaculture, assessing aquaculture legislation and licensing procedures, promoting national capacity building on aquaculture, developing new farming technologies, promoting new species, and harmonizing monitoring of environmental data related to aquaculture[6].

9.3 Issues

The aquaculture and fisheries sector in NENA region faces many challenges, including lack of farmer's adaptability to climate change and resilience to natural disasters and socioeconomic risks, limited awareness on environmental and social impacts of aquaculture, and limited access to quality production inputs and sustainable production technologies. Most NENA countries have not created effective partnership with the FAO global BGI to face these challenges. BGI activities in NENA region have focused on the African sub-region (the People's Democratic Republic of Algeria, the Arab Republic of Egypt, the Kingdom of Morocco and the Republic of Tunisia), with little effort paid to the Asian sub-region.

9.4 The way forward

Urgent dialogue and coordination between NENA governments, private sector and civil societies should be promoted in collaboration with FAO, in order to achieve the FAO's Sustainable Development Goals in the aquaculture sector. FAO should engage in efforts in supporting policy development, advocacy, communication and partnerships to promote responsible management and sustainable development of aquaculture and to minimize environmental risks. In this regard, special attention should be given to the Asian subregion of NENA region. More technical, research and capacity building programmes should be initiated in these countries in order to achieve the SDGs in aquaculture and fisheries sectors.

[6] *Source:* www.fao.org/gfcm/activities/technical-assistance-and-cooperation/fwp-info/en

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