THE ROLE OF IRRIGATION IN FOOD PRODUCTION AND AGRICULTURAL DEVELOPMENT IN THE NEAR EAST REGION

1. INTRODUCTION

The global water crisis has drawn worldwide attention to the urgency of achieving a more efficient use of water resources, particularly in agriculture, to increase crop production and achieve world food security. Considering that a major share of the world's water resources is used in agriculture and that food requirements are increasing while global water resources are limited, irrigated agriculture and the role of efficient irrigation systems and techniques have recently assumed greater importance in increasing food production.

Employing more than 50% of the total population of the developing countries, agriculture is still the primary economic activity and is assumed to play the major role in the economies of most of these countries. However, recent statistics show that 777 million out of the world's 815 million hungry people are in developing countries[1]. Meanwhile, despite the huge water resources available to developing countries, their total irrigated area still accounts for a mere 2.7% of their total land area and only 6.7% of their total agricultural area[2]. Therefore, making the best use of water resources for agriculture and improving irrigation efficiency are urgent needs and prerequisites for sustainable food production in most developing countries, especially those in water-scarce regions like the Near East.

The Near East region (grouping the countries represented in the FAO Regional Office for the Near East) extends from the Atlantic Ocean (Mauritania and Morocco) in the west to Pakistan and Afghanistan in the east, and from Turkey and the Kyrgyz Rep. in the north to Somalia in the south. Thus, it comprises countries which are almost all OIC members (28 OIC countries in addition to Cyprus, Israel and Malta). For the purpose of this paper, the 28 Near East OIC member countries have

[1] FAO, "The State of Food Insecurity in the World 2001".
[2] FAO Database (FAOSTAT).

been grouped in five sub-regions based primarily on geographic conditions and, as far as possible, on hydro-climatic homogeneity.

These sub-regions are: ***Maghreb*** (Algeria, Libya, Mauritania, Morocco, and Tunisia), ***North-eastern Africa*** (Djibouti, Egypt, Somalia, and Sudan), ***Arabian Peninsula*** (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates, and Yemen), ***Middle East*** (Iraq, Jordan, Lebanon, Palestine, Syria, and Turkey), and ***Central Asia***[3] (Afghanistan, Iran, the Kyrgyz Rep., Pakistan, Tajikistan, and Turkmenistan).

With a population of almost 600 million, or 10% of the world's population, increasing at an annual rate of 2.7%, and with a total land area of 18.5 million km^2, or about 14% of the world's total area, the Near East is the most water-scarce region in the world. It concentrates most of the complex water allocation issues of the world. The region receives only 3.6% of the world's precipitation and has as little as 2.2% of its renewable water resources[4]. Taking this into account, and considering that more than 90% of the water withdrawal in the region is used in agriculture, the need for developing modern and efficient irrigation systems and techniques is of prime importance for sustainable food and agricultural production in all countries of the region.

In view of the increasing pressure on natural resources in the Near East and the importance of water resources management, this paper attempts to bring out the importance of the role of irrigation in food production and agricultural development in this region. This is done through reviewing and examining the performance of the countries in the region, particularly the OIC member countries, in terms of land and water use in agriculture and food production with special emphasis on irrigation. The tables in the text present data at the sub-regional level, while the tables in the Annex at the end of this paper provide data at both sub-regional and individual country levels.

[3] For the purposes of this paper, the term is limited to the countries listed in parenthesis and does not include all the countries commonly classified in the region of Central Asia.
[4] FAO's Information System on Water and Agriculture- AQUASTAT.

2. LAND USE IN AGRICULTURE

2.1. Overview[5]

The area extending between the Atlantic Ocean and the Persian Gulf is covered with vast deserts. The Great Desert (the Sahara), extending between the Atlantic Ocean and the Red Sea, comprises large parts of the Maghreb and Northeastern Africa. The area extending between the Red Sea and the Persian Gulf includes the Rub Al Khali (Empty Quarter) desert in the south of the Arabian Peninsula and the Badiat-El-Sham desert in the north of the Arabian Peninsula and the south of the Middle East. In Central Asia, a large part of Iran is covered with desert, as is the case for the southern part of Afghanistan and the southwestern part of Pakistan. The Kara Kurn desert comprises 80 percent of the total area of Turkmenistan.

Moreover, many mountain ranges are found in the Near East region. In the center of the Great Desert, several mountains appear, with the highest peak at an elevation of 3000 meters at Tebetsy Mountain in Libya. In addition to these internal mountains, there are mountain ranges running parallel to the coasts of the Mediterranean and Red Sea. The Atlas mountain range occupies the northwestern corner of the Maghreb, with its peak in Morocco at an elevation of 4165 meters. The Lebanon mountain chain in Lebanon has its highest crest at just over 3000 meters. In Yemen, there is a mountain peak at an elevation of 3268 meters, and in Turkey at an elevation of 4135 meters. The peak of Zagros mountain chain in Iran reaches 4432 meters. The highest peak of the Hindu Kush range on the border between Afghanistan and Pakistan reaches 7690 meters (Tirichmir). In the northeastern part of Central Asia, the Himalayan mountain ranges have peaks reaching almost 8000 meters.

2.2. Total Land Area *versus* Agricultural Land Area

The Near East region covers a total land area[6] of 1813.7 million hectares, or about 14% of the total land area of the world and 24% of that of the developing countries. The Maghreb covers the largest area in

[5] Based mainly on FAO's Information System on Water and Agriculture-AQUASTAT, "General Summary Near East Region".

[6] **Total land area** is the area of the country excluding the area under inland water bodies (major rivers and lakes). 1 km^2 = 100 hectares, or 1 hectare = 0.01 km^2.

the region with 576.8 million hectares while the Middle East covers the smallest area with only 149.6 million hectares. Out of its total land area, the Near East region has an agricultural area[7] of 746.1 million hectares, or 15% of the total agricultural land area in the world and 24% of that in the developing countries. At the sub-regional level, the Arabian Peninsula has the largest agricultural area of 193.3 million hectares (but includes great areas of permanent pastureland for the grazing of livestock) followed by Central Asia and North-eastern Africa. The Middle East has the smallest agricultural area of 64.2 million hectares.

TABLE 1: LAND AREA USED IN AGRICULTURE (Million Hectares)

	Total land	**Agricultural land**	**Arable land**	**Permanent crops land**
Maghreb	576.8	137.4	21.4	4.1
North-eastern Africa	402.2	175.6	20.6	0.7
Arabian Peninsula	300.3	193.3	5.3	0.4
Middle East	149.6	64.2	34.6	4.1
Central Asia	384.7	175.7	50.2	3.0
Total Near East	**1813.7**	**746.1**	**131.9**	**12.3**
As % of:				
World	**13.9**	**15.0**	**9.6**	**9.3**
Developing countries	23.9	24.0	17.7	11.3

Source: Table A.1 and Table A.2 in the Annex.

On the other hand, the arable land[8] in the Near East region covers an area of 131.9 million hectares. This makes only 9.6% of the total arable land area in the world and 17.7% of that in the developing countries. The permanent crops land[9] in the Near East region covers an area of 12.3 million hectares or only 9.3% of the world's permanent crops area and 11.3% of that of the developing countries. Furthermore, large differences exist within the region between the five sub-regions, as is shown in Table 1. With the largest agricultural area, the Arabian Peninsula has the smallest arable and permanent crops land areas. This is due to the fact that a large part of the agricultural area is permanent pastureland used for the grazing of livestock. In contrast, with the

[7] **Agricultural area** is the sum of arable, permanent crops and permanent pastures land areas.

[8] **Arable land** is the land under temporary crops, temporary meadows for mowing or pasture, land under market and kitchen gardens, and land temporarily fallow.

[9] **Permanent crops land** is the area cultivated with crops that occupy the land for long periods and that do not need to be replanted after each harvest. This does not include woodland and forests.

smallest agricultural area, the Middle East comes second after Central Asia in terms of the arable land area, and shares the first rank with the Maghreb in terms of the permanent crops area.

TABLE 2: LAND AREA USED IN AGRICULTURE (Percentages)

	Agricultural land *vs.* total land area	**Arable land *vs.* agricultural land area**	**Permanent crops land *vs.* agricultural land area**
Maghreb	23.8	15.5	3.0
North-eastern Africa	43.7	11.7	0.4
Arabian Peninsula	64.4	2.7	0.2
Middle East	42.9	53.8	6.4
Central Asia	45.7	28.6	1.7
Total Near East	**41.1**	**17.7**	**1.6**
World	**38.0**	**27.6**	**2.7**
Developing countries	40.9	24.0	3.5

Source: Table A.3 in the Annex.

The agricultural land area in the Near East region accounts for 41.1% of its total land area, as against 38% for the whole world and 40.9% for the developing countries (see Table 2). However, the region's arable land area accounts for only 17.7% of its agricultural land area, as against 27.6% for the world and 24% for the developing countries. At the sub-regional level, the Arabian Peninsula recorded the lowest level of only 2.7%, while the Middle East recorded the highest level of 53.8%. At the individual country level, Mauritania, Somalia, Oman, Kuwait, and Saudi Arabia recorded a level of less than 5% (see Table A.3 in the Annex). On the other hand, the permanent crops land area in the region accounts for only 1.6% of its agricultural land area, as against 2.7% for the world and 3.5% for the developing countries. The Middle East recorded the highest level with 6.4%, followed by the Maghreb with 3%. In contrast, the Arabian Peninsula recorded the lowest level with 0.2%, followed by North-eastern Africa with 0.4%. This percentage reached less than 1% in 9 countries for which the data are available (see Table A.3 in the Annex)

It is then clear that while the percentage of agricultural area in total land area of the Near East region is comparable or even slightly higher than that of the world and the developing countries, the percentages of its arable and permanent crops land areas in total agricultural area are still significantly below the average levels of the world and the developing countries. This is due, among other things, to the unsatisfactory use of

land in agriculture, particularly, as we shall see in the following two sections, due to the scarcity of water resources in the region and the insufficient use of water in agriculture. This, together with the use of insufficient irrigation systems and techniques, lead, in turn, to low levels of irrigated agricultural land areas in most parts of the region.

3. WATER RESOURCES AND USE IN AGRICULTURE

4.1. Overview

Because of the aridity prevailing in the region, the Near East is the poorest region in the world in terms of water resources, both globally and per inhabitant. However, the water resources distribution within this vast region, extending over three continents, is far from being uniform. Land relief, location with respect to the sea, latitude and resulting hydro-climatic conditions, and diversity in hydrographic and geological structures, all give rise to extremely different water situations. Many countries in the region are characterised by long coastal boundaries. Only three countries in the region (Afghanistan, the Kyrgyz Rep., and Tajikistan) are landlocked. Moreover, several international rivers cross the Near East region; the most important of which are the Nile in northeastern Africa, which originates outside the region in the Equatorial Lake, and the Euphrates and the Tigris in the Middle East. The Amu Darya, the Syr Darya and Indus in Central Asia (the latter originating outside the region in the Himalayas). Smaller rivers like the Jordan and the Orontes in the Middle East also play a fundamental role in water resources.

4.2. Renewable Water Resources

While the Near East covers 14% of the total area of the world and contains 10% of its population, the region receives only 3.6% of the world's average annual precipitation[10] and has as little as 2.2% of its annual renewable water resources. The region's annual internal renewable water resources[11] account for 22.3% of its average annual precipitation, as against 36.4% for the world. Furthermore, large differences exist between

[10] **Average precipitation**: the double average over space and time of water falling on the country per year (rain, snow or hail).

[11] **Internal renewable water resources**: the average annual flow of rivers and recharge of groundwater generated from endogenous precipitation.

the five sub-regions, as is shown in Table 3. The Maghreb, North-eastern Africa and the Arabian Peninsula have very limited water resources, with less than 50 km^3 annually on average and suffer severe water scarcity, with values per capita varying between 164 m^3/year on average for Arabian Peninsula and 624 m^3/year on average for the Maghreb. In contrast, Central Asia and the Middle East show much higher values, thanks mostly to the abundant flows of water generated in the mountainous areas of Turkey and the Himalayas in Central Asia.

TABLE 3: DISTRIBUTION OF THE RENEWABLE WATER RESOURCES

	Average annual precipitation (km^3/yr)	**Annual internal renewable water resources**		
		(km^3/yr)	As % of precipitation	Per capita m^3/yr
Maghreb	493.0	48.4	9.8	624
North-eastern Africa	1305.9	43.1	3.3	398
Arabian Peninsula	240.4	7.7	3.2	164
Middle East	629.4	239.8	38.1	2047
Central Asia	1299.1	545.6	42.0	2190
Total Near East	**3967.8**	**884.6**	**22.3**	**1476**
World	**110000**	**40000**	**36.4**	**6604**
As % of world	**3.6**	**2.2**		**22.4**

Source: Table A.4 in the Annex.
Note: 1 km^3 = 1 X 10^9 m^3

The internal renewable water resources per capita in the Near East are among the lowest in the world. The average for the region is 1476 m^3/year, as against 6604 m^3/year for the whole world. It ranges from near zero for Kuwait, which has practically no internal renewable water resources, to about 10000 m^3/year for Tajikistan and the Kyrgyz Rep. (see Table A.4 in the Annex). The internal renewable water resources per capita are below 500 m^3/year in 16 countries in the region. Only in four countries (Turkey, the Kyrgy Rep., Tajikistan and Afghanistan), the internal renewable water resources per capita are above 2000 m3/year. Three of these countries act as 'water towers' for the region, with large amounts of water flowing to downstream neighbour countries. They are: Turkey (the Euphrates and the Tigris rivers mainly), the Kyrgyz Rep. and Tajikistan (the Amu Darya and the Syr Darya).

Even when considering the contribution of rivers flowing from the bordering and more humid regions of tropical Africa (the Nile) or

Himalayan Asia (the Indus), the Near East region is still the poorest region in the world in terms of water resources. This is true considering the figures on total renewable water resources (natural and actual)[12] as presented in Table 4 below and Table A.5 in the Annex. The 2009 m^3/year actual total renewable water resources per capita for the near East region is still significantly lower than the 6604 m^3/year for the whole world; it is below 500 m^3/year in 16 countries in the region.

TABLE 4: TOTAL RENEWABLE WATER RESOURCES (TRWR)

	TRWR (km^3/yr)		**Actual TRWR per capita**	**Dependency ratio (*)**
	Natural	**Actual**	m^3/yr	(%)
Maghreb	60.4	60.4	779	19.9
North-eastern Africa	256.8	162.8	1502	83.2
Arabian Peninsula	7.8	7.8	167	1.7
Middle East	348.9	290.7	2482	30.2
Central Asia	701.7	682.0	2738	22.2
Total Near East	**1375.6**	**1203.7**	**2009**	**26.3**

Source: Table A.5 in the Annex.

(*) The part of the total renewable water resources originating outside the country or the region.

Furthermore, many countries in the region depend to a large extent for their renewable water resources on water flows originating outside their borders. The dependency ratio for the region as a whole is 26.3%. While North-eastern Africa recorded the highest water resources dependency ratio of 83.2% followed by the Middle East with 30.2%, the Arabian Peninsula recorded the lowest ratio of only 1.7%. Five countries depend for over 90% for their renewable water resources on other countries: Egypt (Nile river), Mauritania (Senegal river) and Turkmenistan (Amu Darya river) for surface water and Kuwait and Bahrain for groundwater (from Saudi Arabia). Syria and Sudan depend for around 80% on upstream countries (mainly the Euphrates from Turkey and the Nile from Ethiopia), but on the other hand they are located upstream from

[12] **Total actual renewable water resources** is the sum of internal renewable water resources and incoming flow originating outside the country, taking into consideration the quantity of flows reserved to upstream and downstream countries through formal or informal agreements or treaties. This gives the maximum theoretical amount of water actually available for a country at a given moment. The figure may vary with time. **The total natural renewable water resources** has the same meaning with special rules using to take into account the flow of border rivers.

other countries depending on the same rivers (Iraq and Egypt respectively). To a lesser extent, but still over 50% dependent on other countries, are Somalia (Shebelli and Juba rivers) and Iraq (Euphrates and Tigris rivers).

Meanwhile, several countries in the region that have few renewable water resources depend on important non-renewable groundwater basins, partly shared with neighbouring countries. By far, in some countries (Saudi Arabia, Libya and the United Arab Emirates), the largest part of the total water withdrawn is fossil water. However, although groundwater reservoirs may allow storage of huge quantities of water, they cannot be considered sustainable in the long term, as the lack of present recharge would result in the slow depletion of the aquifers. Moreover, the water level decline and the resulting increase in the cost of pumping as well as the deterioration of the water quality in some areas may also make the abstraction of fossil water less attractive with time.

4.3. Water Use in Agriculture

The total water withdrawal[13] in the Near East accounts for 50.5% of the region's internal renewable water resources (IRWR), as against only 8.1% for the whole world. However, while 91.7% of its total water withdrawal is directed towards agriculture, as against 69% for the whole world, the agricultural water withdrawal[14] in the region accounts for only 21% of that of the world. At the sub-regional level, Central Asia has the highest level of water withdrawal for agriculture (95.6%). As we shall see in the next section, this is the sub-region where the largest part of its arable land area is irrigated.

Afghanistan is the country with the largest percentage of water withdrawal directed to agriculture (99%) while Bahrain, with 56.5%, is the country with the lowest percentage. In absolute terms, Central Asia represents 58% of the total water withdrawal for the Near East: Pakistan alone withdrawing 30% (calculated using the data in Table A.6 in the Annex).

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[13] **Total water withdrawal** is the annual quantity of water withdrawn for agricultural, industrial, and domestic purposes. The use of desalinated and treated wastewater is thus included. It does not, however, include other withdrawals (i.e. for other sectors: energy, mining, recreation, navigation, fisheries and environment. These sectors usually have a very low consumption rate).

[14] Including irrigation and livestock watering.

TABLE 5: WATER USE IN AGRICULTURE

	Total water withdrawal km^3/yr	**% of IRWR**	**Agricultural withdrawal** km^3/yr	**% of total withdrawal**
Maghreb	24.9	51.3	20.9	84.2
North-eastern Africa	73.7	171.0	65.0	88.2
Arabian Peninsula	24.3	316.6	21.2	87.2
Middle East	91.1	37.4	77.5	85.1
Central Asia	297.5	54.5	284.3	95.6
Total Near East	**511.5**	**50.5**	**469.0**	**91.7**
World (1990)	**3240.0**	**8.1**	**2235.6**	**69.0**
As % of world	**15.8**		**21.0**	

Source: Table A.6 in the Annex.

Water withdrawal, expressed as a percentage of internal renewable water resources, is an indicator of the region's or the country's capacity to rely on its own renewable sources of water (the pressure on the renewable water resources). Roughly speaking, pressure on water resources is considered high when this percentage is above 25%. Only five countries in the Near East region (Djibouti, Somalia, Turkey, the Kyrgyz Rep., and Tajikistan) are below the 25% limit (see Table A.6 in the Annex). Values above 100% indicate that the country or the region relies, at least, partly on renewable water resources flowing from outside, non-conventional water resources (desalinated water and treated wastewater), or mining its groundwater resources.

In North-eastern Africa, where water withdrawal accounts for 171% of internal renewable water resources (Table 5 above), water transfer plays a crucial role (the Nile flows into the region from upstream countries outside the region). In the Arabian Peninsula, where this percentage is 316.6%, the deficit is mainly made good by the use of fossil and non-conventional water sources. Annual water withdrawal is greater than the internal renewable water resources in 13 countries (see Table A.6 in the Annex). However, 5 of these countries (Mauritania, Egypt, Iraq, Syria, and Turkmenistan) benefit from rivers flowing in from upstream countries, resulting in an annual water withdrawal that is greater than the internal renewable water resources. The remaining 8 countries are those of the Arabian Peninsula (except Yemen), Libya and Jordan. In these countries, water withdrawal is greater than the internal renewable water resources and they have to rely on non-conventional and groundwater water resources. While Tunisia and Yemen have high rates of use of their internal renewable water resources (87.4% and 71.5%

respectively), they do not benefit much from groundwater or non-conventional water resources or even incoming water. It is then likely that these two countries will have to rely increasingly on alternative sources of water in the future.

4. IRRIGATION

4.1. Irrigation Areas

The term 'irrigation area' or 'area under irrigation' refers to the area of land equipped to provide water, other than direct rainfall, to the crops. It includes areas equipped for full and partial (f/p) control irrigation[15], spate irrigation[16] areas, and equipped wetland and inland valley bottoms[17]. It does not include flood recession cropping areas[18] which, when added to the other mentioned areas, the total irrigation area is then called the water managed area, as is shown in Table 6. According to this definition, the total irrigation area in the Near East region covers 48.1 million hectares, or 19.5% of the world irrigation area and 23.2% of that of the developing countries.

Central Asia represents 60% of the total irrigation area in the Near East, although it covers only 21% of the total land area of the region. Pakistan alone, covering 4% of the region, accounts for 33% of the irrigation area. By adding Iran, Turkey, Iraq and Egypt, the five countries have 71% of the areas under irrigation in the region while they cover only 25% of its total land area (calculated using the data in Table A.7 in the Annex).

Full or partial irrigation is by far the most widespread type of irrigation, covering 95.6% of the total irrigation area (calculated using the figures

[15] Physical area of irrigation schemes developed and managed either by government, private estates or farmers, and where a full or partial control of the water is achieved; gardening is included.

[16] It is a method of random irrigation using the floodwaters of a normally dry system. It is practised by building earthen diversion banks across a dry watercourse. The floods or spates are diverted into embanked fields, where the water is pounded until total infiltration.

[17] Parts of cultivated wetlands and inland valley bottoms which have been equipped with water control structures such as intakes, canals, etc.

[18] Areas along rivers where cultivation occurs in the areas exposed as floods recede. The special case of floating rice is included in this category.

TABLE 6: TOTAL IRRIGATION AREA AND WATER MANAGED AREA (000 hectares)

	f/p control (1)	Spate (2)	Equip. wet/ivb (3)	Total irrigation area	Flood recession cropping	Water managed area
Maghreb	2413	305	0	2718	64	2782
North-eastern Africa	5197	196	0	5393	0	5393
Arabian Peninsula	2141	98	0	2239	0	2239
Middle East	8761	0	115	8876	0	8876
Central Asia	27517	1402	0	28919	1241	30160
Total Near East	**46029**	**2001**	**115**	**48145**	**1305**	**49450**
Near East as % of:						
world				**19.5**		**18.0**
Developing countries				**23.2**		

Source: Table A.7 in the Annex.

Notes: **(1)** Full/partial (f/p) control irrigation equipped area. **(2)** Spate irrigation area. **(3)** Equipped wetland and inland valley bottoms.

in Table 6). In relative terms, spate irrigation is most important in the Maghreb, covering 11% of its water managed area. In absolute terms, spate irrigation occupies by far the largest irrigation area in Pakistan, accounting for 70% of the spate irrigation in the whole Near East and 8% of the water managed area in Pakistan. Equipped wetland and inland valley bottoms (ivb) are reported only in Turkey (see Table 7 in the Annex). Flood recession cropping is practised in Pakistan (with 94% of the flood recession cropping area of the whole Near East.

TABLE 7: IRRIGATION AREA AS % OF TOTAL LAND, AGRICULTURAL AND ARABLE AREAS

	Total Irrigation Area As % of		
	Total land area	Agricultural area	Arable area
Maghreb	0.5	2.0	12.7
North-eastern Africa	1.3	3.1	26.2
Arabian Peninsula	0.7	1.2	42.5
Middle East	6.0	13.9	25.8
Central Asia	7.5	16.5	57.6
Total Near East	**2.7**	**6.5**	**36.5**
World	**1.9**	**5.0**	**18.0**
Developing countries	**3.8**	**6.7**	**33.2**

Source: Table A.8 in the Annex.

On the other hand, the total irrigation area in the Near East makes 2.7% of the region's total land area and 6.5% of its agricultural area, as

against 3.8% and 6.7% for the developing countries and 1.9% and 5% for the whole world. It also accounts for 36.5% of the region's arable land area, as against 33.2% for the developing countries and 18% for the world. However, the share of irrigation area in agricultural land varies considerably between the sub-regions and between the countries, as is shown in Table 7 and Table A.8 in the Annex. In Central Asia, 57.6% of the arable area is equipped for irrigation, playing a crucial role in the production of cereals (especially wheat) and cotton. The part of arable area under irrigation is also important in the Arabian Peninsula (42.5%), but less so for the other sub-regions, particularly the Maghreb. However, it is crucial for some countries in these sub-regions, like Egypt where the whole arable land is under irrigation, and Iraq where almost 68% of the arable land area is under irrigation. The part of arable area under irrigation was less than 20% in 8 countries, half of which were in the Maghreb. However, the total irrigation area exceeds the arable land area in Egypt, Oman and Turkmenistan (see Table A.8 in the Annex).

4.2. Sources of Irrigation Water

There are three possible sources of irrigation water in the Near East: surface water, groundwater (renewable or fossil), and non-conventional sources (treated wastewater and desalinated water). Spate irrigation areas, equipped wetland and flood recession cropping areas are all irrigated by surface water[19]. Table 8 shows the origin of irrigation water for the full or partial (f/p) control irrigation equipped areas.

As is shown in Table 8, the origin of irrigation water in the Near East region consists mainly of surface water, but there are significant differences between the sub-regions. The large contribution of surface water in North-eastern Africa (95.6%) and the Middle East (81.8%) reflects the fact that these regions' hydrology is dominated by the presence of large rivers: the Nile, the Euphrates and the Tigris. The Indus, the Amu Darya and Syr Darya are also important for irrigation in Pakistan, the Kyrgyz Rep., Tajikistan and Turkmenistan. The contribution of groundwater is most important in the Arabian Peninsula

[19] It is a method of irrigation where the water is applied to the land (from rivers and lakes) by allowing it to flow by simple gravity, before infiltrating. It includes various systems depending upon the relative magnitude of the surface flooding phase and infiltration phase after accumulation: furrow, border, basin, and flooded irrigation of rice.

where there are no big rivers. Non-conventional water for irrigation is used in 9 countries and plays a fairly important role in the drier sub-regions of the Arabian Peninsula and the Maghreb. In Kuwait, 39% of the irrigated area is irrigated by non-conventional water (treated wastewater and desalinated water). This percentage is 13.6% in Bahrain and less than 6% in all the other countries (see Table A.9 in the Annex).

TABLE 8: SOURCES OF IRRIGATION WATER

	% of full/partial (f/p) control irrigation area		
	Surface water	**Ground-water**	**Non-conventional sources**
Maghreb	43.0	56.2	0.8
North-eastern Africa	95.6	4.3	0.1
Arabian Peninsula	2.4	96.6	1.0
Middle East	81.8	18.2	-
Central Asia	66.0	34.0	0.0
Total Near East	**68.2**	**31.7**	**0.1**

Source: Table A.9 in the Annex.

4.3. Irrigation Techniques

Detailed information on the irrigation techniques used in full or partial (f/p) irrigation schemes was available fully for 18 countries and partially for Algeria and Afghanistan (see Table A.10 in the Annex). Based on this data, surface irrigation is by far the most widely used technique in the Near East, practised on 87.6% of the total full or partial control irrigation area in the region. On the other hand, sprinkler irrigation[20] is practised on 11% and micro-irrigation[21] on 1.4% of the total area.

In Libya and Saudi Arabia, sprinkler irrigation is by far the most predominant (100% and 64% respectively), while in Jordan and the United Arab Emirates, micro-irrigation is the most widely used

[20] It is a method of irrigation by applying water under pressure when the water is sprinkled in the form of artificial rain through lines carrying distribution components: rotary sprinklers, diffusers with permanent water streams, and perforated pipes.

[21] It is a method of irrigation (with different techniques) when water is applied to and causing wetting of only part of the soil in the field at the base of the plant (plant root zone) in small but frequent quantities, i.e. drop by drop. It includes the following terms or systems: trickle irrigation, drip irrigation, daily flow irrigation, drop irrigation, and sip irrigation.

technique, being practised on over half of their full/partial control irrigation areas (59.4% and 56.7% respectively). Together, sprinkler irrigation and micro-irrigation techniques are practised on 38.7% of the full/partial control irrigation area in Lebanon and 36% in Kuwait (see Table A.10 in the Annex). In particular, the arid countries, without large rivers, choose to develop more intensively the micro-irrigation and sprinkler irrigation techniques to save water.

TABLE 9: IRRIGATION TECHNIQUES

	As % of full/partial (f/p) control irrigation area		
	Surface Irrigation	**Sprinkler irrigation**	**Micro-irrigation**
Maghreb	54.1	28.3	0.4
North-eastern Africa	93.8	3.6	2.6
Arabian Peninsula	47.9	48.6	3.4
Middle East	92.9	6.1	1.0
Central Asia	80.9	1.5	0.3
Total Near East	**87.6**	**11.0**	**1.4**

Source: Table A.10 in the Annex.

4.4. Irrigation Intensity and Irrigation Potential

Two indicators are frequently used to assess irrigation intensity. First, the rate of use of land equipped for irrigation, which is that part of the area equipped for full/partial (f/p) control irrigation actually irrigated and used for crop production at least once a year. Second, the cropping intensity, which is the ratio between irrigated crops area and the physical area equipped for irrigation (i.e. the water managed area). In general, these figures are either not available or not reliable at the country level (see Table A.11 in the Annex). Moreover, in some cases, it is not possible in practice to distinguish between these two indicators. This is due to the possibility that one part of the equipped area is not used for certain reasons (abandoned, water shortage, etc.), while the remaining part is cultivated in double or triple cropping. Moreover, figures may vary significantly from one year to another, particularly in the areas where irrigation schemes are facing water availability problems.

However, for 19 countries, information was available on the part of the area equipped for full/partial control irrigation which is actually irrigated (see Table A.11 in the Annex). In all these countries, the rate of the use

of the equipped area was greater than 50%: in 3 countries it was less than 60% and in 9 countries it was reported to be 100%. Overall, the equipped area of these 19 countries represents 23.8 million hectares, or 52% of the equipped area of the whole region (calculated using the figures in Table A. 7 in the Annex). It was also difficult to get reliable information on cropping intensity for the reasons explained above. However, figures available for some countries show a cropping intensity of 1.66 for Egypt, 1.19 for Syria and Mauritania, 1.15 for Oman, 1.08 for Jordan, and 1.03 for Turkmenistan. In Lebanon, Iran, the Kyrgyz Rep. and Tajikistan, the cropping intensity is reported to be 1, and it is also so in Saudi Arabia, Bahrain and Kuwait, probably because no cropping is possible in the hot season.

On the other hand, methods used by countries to estimate their irrigation potential, which is the area of land suitable for irrigation development, vary with significant influence on the results. In computing water available for irrigation, some countries only consider the renewable water resources, while others, especially arid countries, include the availability of groundwater or non-conventional water resources. For this reason, comparison between countries should be made with caution. Thus it is not possible to systematically add up country figures to obtain regional or sub-regional estimates of irrigation potential.

By far, the largest irrigation potential is concentrated in Pakistan and Iran and is based only on renewable water resources (see Table A.11 in the Annex). In only 4 out of the 27 countries for which information was available, over 80% of the irrigation potential is at present already equipped for irrigation: Pakistan (94%), United Arab Emirates (88%), Somalia (83%), and Syria (81%). However, some arid countries, where no agriculture is possible without irrigation, tend to consider the arable land area as the irrigation potential area, for the development of which they would certainly have to rely on the use of groundwater and non-conventional sources of water. This means that, for those countries, any extension of existing irrigation area would require more of these resources if no improvement in water use efficiency is brought about.

5. AGRICULTURE PERFORMANCE AND THE STATE OF FOOD PRODUCTION

As it has been shown in the above section, the Near East is the poorest region in the world in terms of the availability of water for agriculture,

where aridity is prevailing in many countries in the region. Furthermore, inadequate use of land and water resources for agriculture due to the use of insufficient irrigation systems limited the irrigated agricultural areas in most parts of the region. Consequently, this has undoubtedly reflected, as we shall see in this section, in the unsatisfactory performance of agriculture and food production in the region.

Employing more than 37% of the total population and contributing more than 23% to the GDP of the Near East, agriculture is still considered as a primary economic activity and is assumed to play a major role in the economies of many countries in the region. This is particularly true of the North-eastern Africa and Central Asia, and to a lesser extent of the Middle East and the Maghreb (see Table 10). In contrast, agriculture plays a limited role in the economies of the countries in the Arabian Peninsula, where, except Yemen, all of them are oil-exporting countries.

TABLE 10: POPULATION IN AGRICULTURE AND SHARE OF AGRICULTURE IN GDP

	Population in Agriculture 2000		Share of Agriculture in GDP (%)
	(million)	% of total	
Maghreb	22.22	28.6	13.3
North-eastern Africa	50.11	46.2	30.5
Arabian Peninsula	12.42	26.4	12.5
Middle East	28.07	24.0	17.6
Central Asia	109.89	44.1	24.9
Total Near East	**222.71**	**37.2**	**23.4**
World	**2567.00**	**42.4**	**5.0**
Developing countries	**2467.22**	**52.0**	**13.0**

Source: Table A.12 in the Annex.

Drought is a recurring phenomenon in the Near East causing sharp annual fluctuations in crop and livestock production in many countries in the region, but its impact is most evident in cereal production. Following a contraction of 2.7% in agricultural output in 1997, the region experienced a significant recovery in 1998 and recorded a strong agricultural output growth of 8.4%. However, in 1999 and 2000, the dominant factor in the region was again severe drought conditions leading to a 3.9% reduction in net agricultural production in 1999, and to a little improvement in 2000 as production rose by only 0.3%. Cereal production fell by 17.1% and 4.6% in the two consecutive years of drought, respectively (see Table 11).

TABLE 11: NET AGRICULTURAL PRODUCTION GROWTH RATES (%)

Year	Agriculture	Cereals	Crops	Food
1991-95	1.8	0.4	1.8	1.8
1996	9.8	17.1	12.6	10.1
1997	-2.7	-11.5	-6.3	-3.3
1998	8.4	17.0	10.5	9.4
1999	-3.9	-17.1	-6.7	-4.2
2000	0.3	-4.6	0.3	0.3

Source: FAO, "The State of Food and Agriculture 2001", P. 162.

Data on agricultural production of the Near East in the year 2000 (Table 12) indicate that the region's cereal production (110.3 million metric tons) accounts for only 5.4% of the world's total cereal production and 9.3% of that of the developing countries. Cereal production in the region concentrated in Central Asian and Middle East countries, where the two sub-regions together produced 72% of the total cereal production in the region as a whole. Together, Pakistan, Iran and Turkey produced almost 65% of the region's cereals, and when the cereal production of Egypt is added, the four countries alone produced 83% of the total cereal production of the region. In contrast, cereal production in the Arabian Peninsula and the Maghreb is very poor, since the two sub-regions together produced only 6.7% of the total cereal production in the region (calculated using the data in Table A.13 in the Annex). Similar performance has also been observed in the case of the production of wheat, fruit and vegetables.

TABLE 12: AGRICULTURAL PRODUCTION (million metric tons)

	Cereals	Wheat	Fruit	Vegetables
Maghreb	4.5	3.1	5.4	9.5
North-eastern Africa	23.7	6.9	8.1	15.8
Arabian Peninsula	2.9	1.9	2.5	3.9
Middle East	32.7	21.3	15.6	28.5
Central Asia	46.5	31.6	16.7	18.5
Total Near East	**110.3**	**64.8**	**48.3**	**76.2**
As % of:				
World	**5.4**	**11.1**	**10.5**	**11.4**
Developing countries	**9.3**	**24.2**	**14.6**	**15.0**

Source: Table A.13 in the Annex.

According to FAO's report "The State of Food and Agriculture 2001", agricultural production did not keep pace with the rapidly increasing demand for food in the Near East region, resulting in a widening food

gap that had to be filled by imports. The region remained a large importer of agricultural commodities over the last two decades. The region's value of agricultural imports is, on average, about $30 billion a year– three times the value of its exports. The share of agricultural imports in total imports has remained relatively stable at about 16%, but with considerable variations among countries in the region. However, the region is becoming increasingly more dependent on imported food items, especially cereals, followed by dairy products, sugar and vegetables. For example, net cereal imports rose from 6.5 million tons in 1960-71 to 55 million tons in 1999, which is about one-fifth of world cereal imports[22]. This makes the region vulnerable to any sharp rise in the international prices of cereals.

Compared to other regions of the world, the Near East region has relatively lower indicators relating to undernourishment. In absolute terms, some of 73 million people in 23 countries in the region, for which the data are available, were undernourished during the period 1997-99 (see Table A.14 in the Annex and Table 13 below). This represents 13% of the total population in these countries and only 9.4% of the total undernourished people in developing countries. However, these average figures hide a wide range of variation among the sub-regions and countries of the region.

TABLE 13: PREVALENCE OF UNDERNOURISHMENT

	Number of people undernourished (million)		**Proportion of total population (%)**	
	1990-92	**1997-99**	**1990-92**	**1997-99**
Maghreb	3.1	3.8	5	5
North-eastern Africa	15.3	14.7	17	14
Arabian Peninsula	5.2	6.1	16	15
Middle East	2.5	4.7	3	4
Central Asia	38.5	43.7	21	18
Total Near East	**64.6**	**73.0**	**14**	**13**
Developing countries	**816.3**	**777.2**	**20**	**17**

Source: Table A.14 in the Annex.

The Near East region contains two of the most food-insecure countries in the world, Somalia and Afghanistan, where some 75% and 58% of the population, respectively, is undernourished. The proportion of people

[22] FAO, "The State of Food and Agriculture 2001", pp. 164-5.

undernourished is still more than 30% in Tajikistan and Yemen, and higher than 10% in Pakistan, Mauritania and the Kyrgyz Rep. Undernourishment in Iraq (14%) has not improved in recent years. Furthermore, the region still contains 13 low-income food-deficit countries (LIFDCs)[23] (see Table A.14 in the Annex). Recently, food shortages caused by drought and civil strife continued to affect some countries in the region. As of early 2001, Somalia, Sudan, Afghanistan, Iraq, Jordan and Tajikistan were the countries facing food emergencies in the region[24]. Moreover, FAO's Projections indicate that the number of the undernourished in the Near East region would, by 2015, still remain far from the 1996 World Food Summit target of reducing their number by 50%.

6. CONCLUSION

Receiving only 3.6% of the world's precipitation and having as little as 2.2% of its renewable water resources, the Near East is the poorest region in the world in terms of water resources, both globally and per inhabitant. Furthermore, many countries in the region depend to a large extent for their renewable water resources on water flows originating outside their borders (the dependency ratio for the region as a whole is 26.3%). At the same time, the region relies heavily for agriculture on its limited renewable surface and underground water resources (more than 90% of the total water withdrawal in the region is diverted for agriculture). All this makes water a scarce factor in agricultural production particularly food production in the region, (at present, the total irrigation area in the region accounts for only 6.5% of its agricultural area).

Drought is a recurring phenomenon in the region and causes sharp annual fluctuations in agricultural production, especially in food crop production. Agricultural production did not keep pace with the rapidly increasing demand for food in the region, resulting in a widening food gap that is to be filled by imports. Only four countries (Pakistan, Iran, Turkey and Egypt) produce more than 80% of the total cereal production

[23] The countries which are net importers of basic foodstuffs with per capita GNP in 1995 not exceeding the level set by the World Bank to determine eligibility for International Development Association (IDA) 'soft loan' assistance.
[24] FAO, "The State of Food and Agriculture 2001", p. 19.

in the region. The region is, therefore, becoming increasingly more dependent on imported food items, especially cereals, followed by dairy products, sugar and vegetables. Although, on average and compared to other regions, the Near East has relatively lower indicators relating to undernourishment, the region still contains 13 LIFDCs, including some of the most food deficit and insecure countries in the world, where recently some of them faced food emergencies due to drought.

The high level of water scarcity in the Near East is best reflected in the level of purchases of what is known as "virtual water". This refers to the volume of water embedded in commodities that are imported, both food and non-food. As 1 ton of wheat production requires approximately 1000 m^3 of water, the importation of 1 million tons of wheat would correspond to the purchase of 1 billion m^3 of water from abroad. It is estimated that the flow of virtual water into the region equals the annual flow of the Nile River into Egypt[25]. A study has shown that in 1994 food imported into the region was equivalent to 83 billion m^3 of virtual water, or 11.9% of the region's annual renewable water resources[26].

Furthermore, the efficient use of water in agriculture is not adequately addressed by the countries of the region where sustainability of the existing irrigation systems is at stake. While surface irrigation is by far the most widely used system in irrigation, practised on 87.6% of the total full and partial control irrigation area, the most water-saving system through micro-irrigation techniques is only practised on a mere 1.4% of the total irrigation area.

Consequently, huge amounts of the water diverted for irrigation in the region are wasted at the farm level through either deep percolation or surface runoff. These quantities may not be lost when one considers water use in the regional context, since return flows become part of the usable resources elsewhere. However, these losses often represent foregone opportunities for water because they delay the arrival of water at downstream diversions and almost produce poorer quality water at the regional level. Another related problem is that water for irrigation is

[25] J.A. Allan. 1999. A Convenient Solution. UNESCO Courier, February 1999, "quoted in FAO, the State of Food and Agriculture 2001, p. 171".
[26] FAO. 1997. Water Resources of the Near East Region: A Review, p. 24. FAO, Rome 1997.

practically free in many countries in the region, mainly because farmers cannot afford to pay water charges and due also to other social obstacles to charging a fee on water for irrigation and even for other uses. However, this, in turn, provides little incentive for farmers to invest in water-saving technologies such as micro-irrigation techniques. Rather, it encourages them to overuse water.

Considering this situation, the capacity to buy virtual water (i.e. imports of food) is largely determined by export earnings, which, in turn, are unsustainable in many countries in the region. At the same time, the alternative of pumping and piping fossil and/or desalinated water over long distances for cereals and fodder production, as attempted in some countries in the region, is an exceptional occurrence and would not be sustainable over the long term. Therefore, unless further progress in the management of the scarce water resources is made, particularly regarding irrigation efficiency, the region appears to be structurally unable to feed its increasing population and will probably need to rely more and more on virtual water, i.e. imports of external food production.

Taking all the above into account, efficient irrigation in the Near East has a vital role to play in sustainable food production and agricultural development in the future. However, irrigated agriculture in the region faces a number of difficult problems. One of the major concerns is the generally poor efficiency with which water resources have been used for irrigation. The future emphasis must be directed towards increasing the efficiency of water use systems and increasing water productivity, getting more crops per drop, as well as moving seriously towards tapping new non-conventional water resources to increase agricultural productivity.

Concerted and focused development efforts by the countries of the region should be emphasised to increase the productivity of land through the efficient use of water resources for agriculture. A fuller use of land and water resources by the development of efficient irrigation systems lead to sustainable increases in food production. Therefore, the suitability of land for irrigated agriculture should be assessed within the process of land evaluation (which crops to grow where and related questions). This is the process through which the selection of suitable land, cropping, and irrigation are decided. This should be physically and financially practicable and economically viable.

Promoting and providing modern techniques and water-saving technologies of irrigation as well as shifting from surface irrigation system to pressurized irrigation will contribute to the goal of achieving sustainable food production. Capacity building, extension services, training and education in irrigation and water resources management for sustainable food production and agricultural development in rural areas offer much scope to improve efficient irrigation schemes. Quantitative targets for new irrigation development and improvement of the existing irrigation schemes are to be estimated on the basis of food requirements, agro-climatic zones and availability of water and land.

Improved planning with users' participation at the planning and design stages of new irrigation schemes and/or the rehabilitation of the existing schemes as well as the provision of extension and training services maximize the positive socio-economic impacts of irrigation projects and improve their sustained operation. For irrigation projects to be economically viable, they need to complement other activities in the country or the region and to consider the effects of any other development, such as agro-industries or new roads. The socio-economic impacts of irrigation projects are also significant outside the country. New projects will both place demands on the region (marketing, migration, physical infrastructure) and contribute to the regional development.

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ANNEX [(*)]

TABLE A.1: TOTAL POPULATION AND LAND AREA

Sub-regions & Countries	Total Population 2000 (million)	Total Land Area (000 hectares)*
Maghreb:	**77.58**	**576816**
Algeria	30.29	238174
Libya	5.29	175954
Mauritania	2.66	102522
Morocco	29.88	44630
Tunisia	9.46	15536
North-eastern Africa:	**108.39**	**402197**
Djibouti	0.63	2318
Egypt	67.88	99545
Somalia	8.78	62734
Sudan	31.10	237600
Arabian Peninsula:	**46.97**	**300323**
Bahrain	0.64	69
Kuwait	1.91	1782
Oman	2.54	21246
Qatar	0.57	1100
Saudi Arabia	20.35	214969
United Arab Emirates	2.61	8360
Yemen	18.35	52797
Middle East:	**117.12**	**149609**
Iraq	22.95	43737
Jordan	4.91	8893
Lebanon	3.50	1023
Palestine	2.90	618
Syria	16.19	18375
Turkey	66.67	76963
Central Asia:	**249.11**	**384730**
Afghanistan	21.77	65209
Iran	70.33	162200
Kyrgyz Rep.	4.92	19180
Pakistan	141.26	77088
Tajikistan	6.09	14060
Turkmenistan	4.74	46993
Total Near East	**599.17**	**1813675**
As % of:		
World	**9.9**	**13.9**
Developing countries	**12.6**	**23.9**

Source: FAO Database (FAOSTAT).
(*) 1 hectare = 0.01 km^2.

[(*)] Cyprus, Israel and Malta are excluded from the total Near East figures in all the tables.

TABLE A.2: LAND AREA USED IN AGRICULTURE
(000 hectares)

Sub-regions & Countries	Agricultural land	Arable land	Permanent crops land
Maghreb:	**137360**	**21353**	**4057**
Algeria	42715	7700	515
Libya	15450	1815	335
Mauritania	39750	488	12
Morocco	30445	8500	945
Tunisia	9000	2850	2250
North-eastern Africa:	**175565**	**20577**	**688**
Djibouti	1300	-	-
Egypt	3300	2834	466
Somalia	44065	1043	22
Sudan	126900	16700	200
Arabian Peninsula:	**193258**	**5264**	**434**
Bahrain	10	3	3
Kuwait	143	6	1
Oman	1077	16	61
Qatar	71	18	3
Saudi Arabia	173785	3594	191
United Arab Emirates	439	82	52
Yemen	17733	1545	123
Middle East:	**64243**	**34576**	**4067**
Iraq	9540	5200	340
Jordan	1178	244	143
Lebanon	324	180	128
Palestine	384	113	121
Syria	13767	4701	801
Turkey	39050	24138	2534
Central Asia:	**175680**	**50172**	**3017**
Afghanistan	38054	7910	144
Iran	63265	17300	1965
Kyrgyz Rep.	10726	1368	67
Pakistan	26880	21234	646
Tajikistan	4360	730	130
Turkmenistan	32395	1630	65
Total Near East	**746106**	**131942**	**12263**
As % of:			
World	**15.0**	**9.6**	**9.3**
Developing countries	**24.0**	**17.7**	**11.3**

Source: FAO Database (FAOSTAT).

TABLE A.3: LAND USE IN AGRICULTURE (Percentages)

Sub-regions & Countries	Agricultural land *vs.* total land area	Arable land *vs.* agricultural land area	Permanent crops land *vs.* agricultural land area
Maghreb:	**23.8**	**15.5**	**3.0**
Algeria	17.9	18.0	1.2
Libya	8.8	11.7	2.2
Mauritania	38.8	1.2	0.0
Morocco	68.2	27.9	3.1
Tunisia	57.9	31.7	25.0
North-eastern Africa:	**43.7**	**11.7**	**0.4**
Djibouti	56.1	-	-
Egypt	3.3	85.9	14.1
Somalia	70.2	2.4	0.0
Sudan	53.4	13.2	0.2
Arabian Peninsula:	**64.4**	**2.7**	**0.2**
Bahrain	14.5	30.0	30.0
Kuwait	8.0	4.2	0.7
Oman	5.1	1.5	5.7
Qatar	6.5	25.4	4.2
Saudi Arabia	80.8	2.1	0.1
United Arab Emirates	5.3	18.7	11.8
Yemen	33.6	8.7	0.7
Middle East:	**42.9**	**53.8**	**6.4**
Iraq	21.8	54.5	3.6
Jordan	13.2	20.7	12.1
Lebanon	31.7	55.6	39.5
Palestine	62.1	29.4	31.5
Syria	74.9	34.1	5.8
Turkey	50.7	61.8	6.5
Central Asia:	**45.7**	**28.6**	**1.7**
Afghanistan	58.4	20.8	0.4
Iran	39.0	27.3	3.1
Kyrgyz Rep.	55.9	12.8	0.6
Pakistan	34.9	79.0	2.4
Tajikistan	31.0	16.7	3.0
Turkmenistan	68.9	5.0	0.2
Total Near East	**41.1**	**17.7**	**1.6**
World	**38.0**	**27.6**	**2.7**
Developing countries	**40.9**	**24.0**	**3.5**

Source: Calculated using the data in Table A.1 and Table A.2 above.

TABLE A.4: DISTRIBUTION OF THE RENEWABLE WATER RESOURCES

Sub-regions & Countries	Average annual precipitation million m^3/yr	Annual internal renewable water resources (IRWR)		
		million m^3/yr	As % of precipitation	Per capita m^3/yr
Maghreb:	**492970**	**48420**	**9.8**	**624**
Algeria	161900	13900	8.6	459
Libya	45700	600	1.3	113
Mauritania	101500	400	0.4	150
Morocco	150000	30000	20.0	1004
Tunisia	33870	3520	10.4	372
North-eastern Africa:	**1305900**	**43100**	**3.3**	**398**
Djibouti	34100	300	0.9	476
Egypt	18000	1800	10.0	27
Somalia	161300	6000	3.7	683
Sudan	1092500	35000	3.2	1125
Arabian Peninsula:	**240390**	**7690**	**3.2**	**164**
Bahrain	49	4	8.2	6
Kuwait	3136	0	0.0	0
Oman	11470	985	8.6	388
Qatar	825	51	6.2	89
Saudi Arabia	126800	2400	1.9	118
United Arab Emirates	8360	150	1.8	57
Yemen	89750	4100	4.6	223
Middle East:	**629360**	**239760**	**38.1**	**2047**
Iraq	67500	35200	52.1	1534
Jordan	8390	680	8.1	138
Lebanon	8600	880	10.2	251
Syria	46670	7000	15.0	432
Turkey	498200	196000	39.3	2940
Central Asia:	**1299100**	**545610**	**42.0**	**2190**
Afghanistan	195600	55000	28.1	2526
Iran	411600	128500	31.2	1827
Kyrgyz Rep.	106500	46450	43.6	9441
Pakistan	393300	248000	63.1	1756
Tajikistan	98900	66300	67.0	10887
Turkmenistan	93200	1360	1.5	287
Total Near East	**3967720**	**884580**	**22.3**	**1476**
World	**110000000**	**40000000**	**36.4**	**6604**

Source: FAO's Information System on Water and Agriculture (AQUASTAT).

TABLE A.5: TOTAL RENEWABLE WATER RESOURCES (TRWR)

Sub-regions & Countries	TRWR million m^3/yr		Actual TRWR per capita	Dependency Ratio (*)
	Natural	**Actual**	m^3/yr	(%)
Maghreb:	**60420**	**60420**	**779**	**19.9**
Algeria	14300	14300	472	2.8
Libya	600	600	113	0.0
Mauritania	11400	11400	4286	96.5
Morocco	30000	30000	1004	0.0
Tunisia	4120	4120	436	14.6
North-eastern Africa:	**256840**	**162840**	**1502**	**83.2**
Djibouti	300	300	476	0.0
Egypt	86800	58300	859	96.9
Somalia	15740	15740	1793	61.9
Sudan	154000	88500	2846	77.3
Arabian Peninsula:	**7824**	**7824**	**167**	**1.7**
Bahrain	116	116	181	96.6
Kuwait	20	20	10	100.0
Oman	985	985	388	0.0
Qatar	53	53	93	3.8
Saudi Arabia	2400	2400	118	0.0
United Arab Emirates	150	150	57	0.0
Yemen	4100	4100	223	0.0
Middle East:	**348917**	**290729**	**2482**	**30.2**
Iraq	96420	75420	3286	63.5
Jordan	880	880	179	22.7
Lebanon	4837	4407	1259	0.8
Syria	46080	26260	1622	84.8
Turkey	200700	183762	2756	2.3
Central Asia:	**701733**	**681970**	**2738**	**22.2**
Afghanistan	65000	65000	2986	15.4
Iran	137510	137510	1955	6.6
Kyrgyz Rep.	69700	20580	4183	0.0
Pakistan	429370	418270	2961	40.7
Tajikistan	82	15890	2609	0.0
Turkmenistan	71	24720	5215	94.5
Total Near East	**1375734**	**1203783**	**2009**	**26.3**

Source: FAO's Information System on Water and Agriculture (AQUASTAT).
(*) The part of the total renewable water resources originating outside the country or the region.

TABLE A.6: WATER USE IN AGRICULTURE

Sub-regions & Countries	Total water withdrawal million m^3/yr	% of IRWR*	Agricultural withdrawal million m^3/yr	% of total withdrawal
Maghreb:	**24850**	**51.3**	**20927**	**84.2**
Algeria	4500	32.4	2700	60.0
Libya	4600	766.7	4000	87.0
Mauritania	1630	407.5	1319	80.9
Morocco	11045	36.8	10180	92.2
Tunisia	3075	87.4	2728	88.7
North-eastern Africa:	**73718**	**171.0**	**64993**	**88.2**
Djibouti	8	2.7	7	87.5
Egypt	55100	3061.1	47400	86.0
Somalia	810	13.5	786	97.0
Sudan	17800	50.9	16800	94.4
Arabian Peninsula:	**24343**	**316.6**	**21234**	**87.2**
Bahrain	239	5975.0	135	56.5
Kuwait	538	-	324	60.2
Oman	1223	124.2	1148	93.9
Qatar	285	558.8	211	74.0
Saudi Arabia	17018	709.1	15308	90.0
United Arab Emirates	2108	1405.3	1408	66.8
Yemen	2932	71.5	2700	92.1
Middle East:	**91087**	**37.4**	**77492**	**85.1**
Iraq	42800	121.6	39380	92.0
Jordan	984	144.7	737	74.9
Lebanon	1293	146.9	875	67.7
Syria	14410	205.9	13600	94.4
Turkey	31600	16.1	22900	72.5
Central Asia:	**297483**	**54.5**	**284352**	**95.6**
Afghanistan	26110	47.5	25849	99.0
Iran	70034	54.5	64155	91.6
Kyrgyz Rep.	10086	21.7	9496	94.2
Pakistan	155600	62.7	150600	96.8
Tajikistan	11874	17.9	10961	92.3
Turkmenistan	23779	1748.5	23291	97.9
Total Near East	**511481**	**50.5**	**468998**	**91.7**
World (1990)	**3240000**	**8.1**	**2235600**	**69.0**

Source: FAO's Information System on Water and Agriculture (AQUASTAT).
(*) IRWR: Internal Renewable Water Resources.

TABLE A.7: TOTAL IRRIGATION AREA AND WATER MANAGED AREA (000 hectares)

Sub-regions & Countries	f/p control (1)	Spate (2)	Equip. Wet/ivb. (3)	Total irrigation area	Flood recession cropping	Water managed area
Maghreb:	**2413**	**305**	**0**	**2718**	**64**	**2782**
Algeria	446	110	0	556	0	556
Libya	470	0	0	470	0	470
Mauritania	49	0	0	49	64	113
Morocco	1093	165	0	1258	0	1258
Tunisia	355	30	0	385	0	385
North-eastern Africa:	**5197**	**196**	**0**	**5393**	**0**	**5393**
Djibouti	1	0	0	1	0	1
Egypt	3246	0	0	3246	0	3246
Somalia	50	150	0	200	0	200
Sudan	1900	46	0	1946	0	1946
Arabian Peninsula:	**2141**	**98**	**0**	**2239**	**0**	**2239**
Bahrain	3	0	0	3	0	3
Kuwait	5	0	0	5	0	5
Oman	62	0	0	62	0	62
Qatar	13	0	0	13	0	13
Saudi Arabia	1608	0	0	1608	0	1608
United Arab Emirates	67	0	0	67	0	67
Yemen	383	98	0	481	0	481
Middle East:	**8761**	**0**	**115**	**8876**	**0**	**8876**
Iraq	3525	0	0	3525	0	3525
Jordan	64	0	0	64	0	64
Lebanon	88	0	0	88	0	88
Syria	1013	0	0	1013	0	1013
Turkey	4071	0	115	4186	0	4186
Central Asia:	**27517**	**1402**	**0**	**28919**	**1241**	**30160**
Afghanistan	2386	0	0	2386	0	2386
Iran	7264	0	0	7264	10	7274
Kyrgyz Rep.	1077	0	0	1077	0	1077
Pakistan	14327	1402	0	15729	1231	16960
Tajikistan	719	0	0	719	0	719
Turkmenistan	1744	0	0	1744	0	1744
Total Near East	**46029**	**2001**	**115**	**48145**	**1305**	**49450**
World				**246409**		**274166**
Developing countries				**207458**		
Near East as % of:						
World				**19.5**		**18.0**
Developing countries				**23.2**		

Source: FAO's Information System on Water and Agriculture (AQUASTAT).

Notes: **(1)** Full/partial (f/p) control irrigation equipped area.

(2) Spate irrigation area.

(3) Equipped wetland and inland valley bottoms.

TABLE A.8: TOTAL IRRIGATION AREA AS % OF TOTAL LAND, AGRICULTURAL AND ARABLE AREAS

Sub-regions & Countries	Total Irrigation Area As % of		
	Total land area	Agricultural area	Arable area
Maghreb:	**0.5**	**2.0**	**12.7**
Algeria	0.2	1.3	7.2
Libya	0.3	3.0	25.9
Mauritania	0.0	0.1	10.0
Morocco	2.8	4.1	14.8
Tunisia	2.5	4.3	13.5
North-eastern Africa:	**1.3**	**3.1**	**26.2**
Djibouti	0.0	0.1	-
Egypt	3.3	98.4	114.5(*)
Somalia	0.3	0.5	19.2
Sudan	0.8	1.5	11.7
Arabian Peninsula:	**0.7**	**1.2**	**42.5**
Bahrain	4.3	30.0	100.0
Kuwait	0.3	3.5	83.3
Oman	0.3	5.8	387.5(*)
Qatar	1.2	18.3	72.2
Saudi Arabia	0.7	0.9	44.7
United Arab Emirates	0.8	15.3	81.7
Yemen	0.9	2.7	31.1
Middle East:	**6.0**	**13.9**	**25.8**
Iraq	8.1	36.9	67.8
Jordan	0.7	5.4	26.2
Lebanon	8.6	27.2	48.9
Syria	5.5	7.4	21.5
Turkey	5.4	10.7	17.3
Central Asia:	**7.5**	**16.5**	**57.6**
Afghanistan	3.7	6.3	30.2
Iran	4.5	11.5	42.0
Kyrgyz Rep.	5.6	10.0	78.7
Pakistan	20.4	58.5	74.1
Tajikistan	5.1	16.5	98.5
Turkmenistan	3.7	5.4	107.0(*)
Total Near East	**2.7**	**6.5**	**36.5**
World	**1.9**	**5.0**	**18.0**
Developing countries	**3.8**	**6.7**	**33.2**

Source: FAO Database (FAOSTAT).

(*) Total irrigation area exceeds the arable land area.

TABLE A.9: SOURCE OF IRRIGATION WATER

Sub-regions & Countries	% of full/partial (f/p) control irrigation area		
	Surface water	**Ground-water**	**Non-conventional sources**
Maghreb:	**43.0**	**56.2**	**0.8**
Algeria	-	-	-
Libya	-	-	-
Mauritania	90.4	9.6	0.0
Morocco	68.3	31.1	0.6
Tunisia	37.3	60.7	2.0
North-eastern Africa:	**95.6**	**4.3**	**0.1**
Djibouti	0.0	100.0	0.0
Egypt	95.4	4.5	0.1
Somalia	-	-	-
Sudan	96.0	4.0	0.0
Arabian Peninsula:	**2.4**	**96.6**	**1.0**
Bahrain	0.0	86.4	13.6
Kuwait	0.0	61.0	39.0
Oman	0.0	100.0	0.0
Qatar	0.0	94.2	5.8
Saudi Arabia	3.2	95.6	1.2
United Arab Emirates	0.0	100.0	0.0
Yemen	0.0	100.0	0.0
Middle East:	**81.8**	**18.2**	**-**
Iraq	93.8	6.2	0.0
Jordan	39.7	54.6	5.7
Lebanon	54.3	45.7	0.0
Palestine	53.7	46.3	0.0
Syria	39.8	60.2	0.0
Turkey	83.5	16.5	0.0
Central Asia:	**66.0**	**34.0**	**0.0**
Afghanistan	84.6	15.4	0.0
Iran	49.9	50.1	0.0
Kyrgyz Rep.	99.0	1.0	0.0
Pakistan	66.0	34.0	0.0
Tajikistan	87.0	9.0	3.0
Turkmenistan	98.0	2.0	0.0
Total Near East	**68.2**	**31.7**	**0.1**

Source: FAO's Information System on Water and Agriculture (AQUASTAT).

TABLE A.10: IRRIGATION TECHNIQES

Sub-regions & Countries	% of full/partial (f/p) control irrigation area		
	Surface irrigation	**Sprinkler irrigation**	**Micro-irrigation**
Maghreb:	**54.1**	**28.3**	**0.4**
Algeria	-	9.0	-
Libya	0.0	100.0	0.0
Morocco	90.2	9.4	0.4
Tunisia	82.8	15.5	1.7
North-eastern Africa:	**93.8**	**3.6**	**2.6**
Egypt	93.8	3.6	2.6
Arabian Peninsula:	**47.9**	**48.6**	**3.4**
Bahrain	83.3	3.3	16.7
Kuwait	60.0	12.0	24.0
Oman	93.5	2.6	3.2
Saudi Arabia	34.0	64.0	2.0
United Arab Emirates	37.3	6.0	56.7
Yemen	100.0	0.0	0.0
Middle East:	**92.9**	**6.1**	**1.0**
Jordan	31.3	9.4	59.4
Lebanon	61.4	23.9	14.8
Syria	96.8	3.0	0.2
Turkey	93.5	6.5	0.0
Central Asia:	**80.9**	**1.5**	**0.3**
Afghanistan	-	4.8	-
Iran	98.7	0.6	0.6
Kyrgyz Rep.	96.6	3.4	0.0
Tajikistan	100.0	0.0	0.0
Turkmenistan	100.0	0.0	0.0
Total Near East	**87.6**	**11.0**	**1.4**

Source: FAO's Information System on Water and Agriculture (AQUASTAT).

TABLE A.11: IRRIGATION INTENSITY AND IRRIGATION POTENTIAL

Sub-regions & Countries	Rate of equipped area (f/p) actually irrigated (%)	Irrigated crops area (000 hectares)	Cropping intensity ratio	Irrigation Potential Area (000 hectares
Maghreb:				
Algeria	82.2	-	-	730
Libya	51.1	-	-	750
Mauritania	54.4	135	1.19	221
Morocco	-	1073	0.85	1653
Tunisia	90.7	308	0.80	563
North-eastern Africa:				
Djibouti	60.4	0.4	0.40	1
Egypt	100.0	5379	1.66	4435
Somalia	-	164	0.82	240
Sudan	63.2	1012	0.52	2784
Arabian Peninsula:				
Bahrain	100.0	3	1.00	4
Kuwait	100.0	5	1.00	25
Oman	100.0	71	1.15	86
Qatar	66.4	9	0.69	62
Saudi Arabia	100.0	1608	1.00	1620
United Arab Emirates	81.7	55	0.82	76
Yemen	-	-	-	490
Middle East:				
Iraq	54.9	-	-	5554
Jordan	-	69	1.08	85
Lebanon	-	88	1.00	178
Syria	-	1204	1.19	1250
Turkey	74.0	-	-	8500
Central Asia:				
Afghanistan	-	-	-	2386
Iran	100.0	7264	1.00	15000
Kyrgyz Rep.	100.0	1077	1.00	2247
Pakistan	-	-	-	17950
Tajikistan	100.0	719	1.00	755
Turkmenistan	100.0	1794	1.03	2353
Total Near East				

Source: FAO's Information System on Water and Agriculture (AQUASTAT).

TABLE A.12: POPULATION IN AGRICULTURE AND SHARE OF AGRICULTURE IN GDP

Sub-regions & Countries	Population in Agriculture 2000		Share of Agriculture in GDP (*)
	(million)	% of total	(%)
Maghreb:	22.22	**28.6**	**13.3**
Algeria	7.26	24.0	12.0
Libya	0.32	6.0	5.0
Mauritania	1.41	52.9	25.0
Morocco	10.91	36.5	13.0
Tunisia	2.33	24.6	12.5
North-eastern Africa:	**50.11**	**46.2**	**30.5**
Djibouti	-	-	3.0
Egypt	24.87	36.6	17.0
Somalia	6.25	71.2	58.0
Sudan	18.99	61.1	39.0
Arabian Peninsula:	**12.42**	**26.4**	**12.5**
Bahrain	0.01	1.1	1.0
Kuwait	0.02	1.1	1.0
Oman	0.91	35.8	2.7
Qatar	0.01	1.2	1.0
Saudi Arabia	2.00	9.8	7.0
United Arab Emirates	0.13	4.9	2.5
Yemen	9.35	50.9	17.0
Middle East:	**28.07**	**24.0**	**17.6**
Iraq	2.32	10.1	19.5
Jordan	0.56	11.4	3.0
Lebanon	0.13	3.7	12.0
Palestine	0.06	2.2	7.0
Syria	4.49	27.8	26.0
Turkey	20.50	30.7	16.0
Central Asia:	**109.89**	**44.1**	**24.9**
Afghanistan	14.58	67.0	-
Iran	18.54	26.4	20.0
Kyrgyz Rep.	1.26	25.7	38.0
Pakistan	71.87	50.9	26.0
Tajikistan	2.06	33.8	19.8
Turkmenistan	1.58	33.3	27.0
Total Near East	**222.71**	**37.2**	**23.4**
World	**2567.00**	**42.4**	**5.0**
Developing countries	**2467.22**	**52.0**	**13.0**

Sources: FAO Database (FAOSTAT).
(*) In 2000 or latest available year.

TABLE A.13: AGRICULTURAL PRODUCTION (Thousand metric tons)

Sub-regions & Countries	Cereals	Wheat	Fruit	Vegetables
Maghreb:	**4486**	**3116.4**	**5439**	**9408**
Algeria	935	760	1428	2576
Libya	213	125	381	905
Mauritania	235	0.4	25	14
Morocco	2008	1381	2681	3719
Tunisia	1095	850	924	2194
North-eastern Africa:	**23750.01**	**6868**	**8078**	**15846**
Djibouti	0.01	-	-	24
Egypt	20105	6564	6889	14615
Somalia	313	1	216	73
Sudan	3332	303	973	1134
Arabian Peninsula:	**2900.38**	**1944.54**	**2529**	**3924**
Bahrain	-	-	22	12
Kuwait	3	1	10	130
Oman	5	1	318	193
Qatar	6	0.16	18	55
Saudi Arabia	2214	1800	1192	1821
United Arab Emirates	0.38	0.38	378	1129
Yemen	672	142	591	584
Middle East:	**32738**	**21276**	**15544**	**28437**
Iraq	1170	555	1215	1908
Jordan	57	25	236	869
Lebanon	96	60	1313	1324
Palestine	31	31	290	386
Syria	3513	3105	1880	1851
Turkey	27871	17500	10610	22099
Central Asia:	**46462**	**31639**	**16739**	**18549**
Afghanistan	-	-	-	-
Iran	12874	8088	10868	11645
Kyrgyz Rep.	1550	1039	187	889
Pakistan	30471	21079	5179	4977
Tajikistan	359	283	299	490
Turkmenistan	1208	1150	206	548
Total Near East	**110336.4**	**64843.94**	**48329**	**76164**
As % of:				
World	**5.4**	**11.1**	**10.5**	**11.4**
Developing countries	**9.3**	**24.2**	**14.6**	**15.0**

Source: FAO Database (FAOSTAT).

TABLE A.14: PREVALENCE OF UNDERNURISHMENT

Sub-regions & Countries	Number of people undernourished (million)		Proportion of total population (%)	
	1990-92	1997-99	1990-92	1997-99
Maghreb:	**3.1**	**3.8**	**5**	**5**
Algeria	1.3	1.7	5	7
Libya	0.0	0.0	0.0	0.0
Mauritania (*)	0.3	0.3	15	12
Morocco (*)	1.4	1.8	5	6
Tunisia	0.1	0.0	1	0.0
North-eastern Africa:	**15.3**	**14.7**	**17**	**14**
Egypt (*)	2.6	2.4	5	4
Somalia (*)	4.8	6.0	67	75
Sudan (*)	7.9	6.3	31	21
Arabian Peninsula:	**5.2**	**6.1**	**16**	**15**
Kuwait	0.5	0.1	23	4
Saudi Arabia	0.2	0.2	1	1
United Arab Emirates	0.1	0.1	5	4
Yemen (*)	4.4	5.7	36	34
Middle East:	**2.5**	**4.7**	**3**	**4**
Iraq	1.2	3.0	7	14
Jordan	0.1	0.2	3	5
Lebanon	0.1	0.1	4	3
Syria (*)	0.2	0.2	2	1
Turkey	0.9	1.2	2	2
Central Asia:	**38.5**	**43.7**	**21**	**18**
Afghanistan (*)	9.3	12.1	64	58
Iran	2.7	3.5	4	5
Kyrgyz Rep. (*)	-	0.5	-	10
Pakistan (*)	26.5	24.4	24	18
Tajikistan (*)	-	2.8	-	47
Turkmenistan (*)	-	0.4	-	9
Total Near East	**64.6**	**73.0**	**14**	**13**
Developing countries	**816.3**	**777.2**	**20**	**17**

Source: FAO, "The State of Food Insecurity in the World 2001".

(*) In addition to Djibouti, these countries are classified as low-income food-deficit countries (LIFDCs), in which are net importers of basic foodstuffs with per capita GNP in 1995 not exceeding the level set by the World Bank to determine eligibility for International Development Association (IDA) 'soft loan' assistance.