Water and Food Security in the Arab Region

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Abstract The Arab region is characterized by high population growth rate, large and rapidly increasing food deficits, limited water resources, and highly variable income levels both within and between countries. Although crop yield values have gradually increased over the last few decades, the Arab countries are still unable to feed themselves using their limited water resources, and they are net importers of food supplies. The situation is likely to deteriorate with increasing water shortages which threaten the locally produced food supply due to, among others, aquifer depletion, salinization of soils, climate change, and reallocation of agricultural water to other sectors and users.

The most viable option is to increase agricultural water productivity of the arid Arab region, not the agricultural land productivity. Cropping pattern shift policy could be adjusted through applying a system for financial incentives to encourage the farmers to cultivate less water-consumption crops. A resilient agriculture requires higher effectiveness with respect to increasing the use efficiency of natural resources and agricultural outputs. Agricultural trade liberalization could have an important role to help achieve the important objective of food security in some countries.

Keywords Food deficits • Water scarcity • Water productivity • Trade • Food security

1 Introduction

By 2050, the world's population is expected to reach 9.1 billion, a 50% increase compared to 2000. Nearly all of this population increase will occur in developing countries. Urbanization will continue at an accelerated pace, and about 70% of the

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R. Choukr-Allah et al. (eds.), *Integrated Water Resources Management in the Mediterranean Region: Dialogue Towards New Strategy*,
DOI 10.1007/978-94-007-4756-2_16, © Springer Science+Business Media Dordrecht 2012

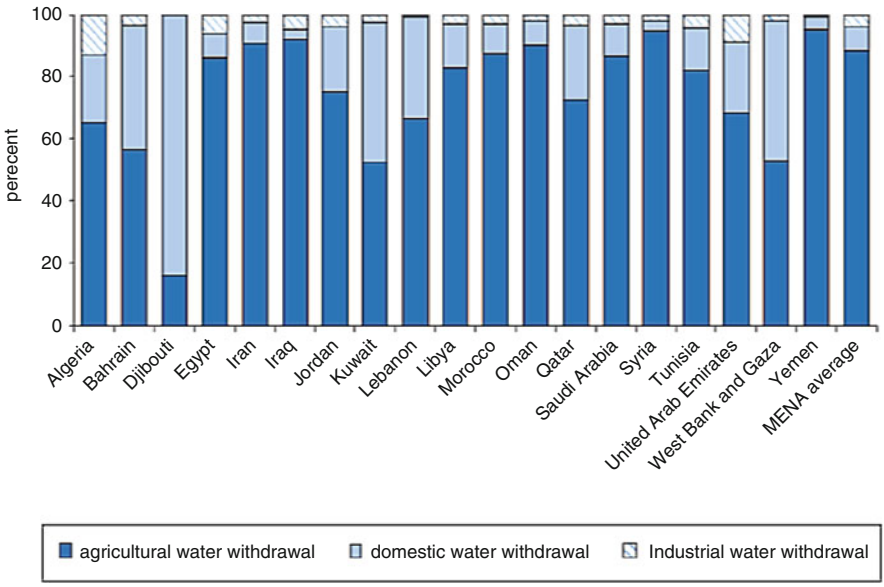


Fig. 1 Water withdrawal per sector in the MENA countries

world's population will be living in towns and cities. In order to feed this larger, more urban, and partially richer population, it is estimated that food production (net of food used for biofuels) must increase by 70–110 % at the global level and at least doubling in the developing countries. The estimate of 110% for future food requirement assumes changes in dietary adjustment of food demand (WWF6 2011). A major concern that currently dominates the political, economic, and social life in many countries is how to continue securing food supplies. "'Food security' exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life." The current global food security situation is highly unstable, driven by dynamics in energy prices, poor harvests, rising demand from a growing population, use of biofuels, and producer-country export bans. These factors, individually and combined, result in sharp price increases and disruption to world grain markets, the brunt of which are felt by the world's poorest nations.

Meanwhile, water use has been growing globally at more than twice the rate of population increase in the last century, and an increasing number of regions are reaching the limit at which reliable water services can be delivered. Essentially, demographic growth and economic development are putting unprecedented pressures on renewable, but finite, water resources, particularly in arid regions. Water shortages make the problem of food security even worst as it reduces global food supply through reductions in irrigated agricultural production. Unfortunately, while agriculture consumes large amounts of water, its use is characterized by low efficiency. Globally, about 65% of water abstractions go to agriculture, while this

percent rises up to 90% in many Arab countries (Fig. 1). Exactly how much water will be needed to meet projected food demand is not well understood, but studies suggest that at least 20% more irrigation water will be needed by 2025 (FAO 2006). This represents a great challenge for water-scarce countries with limited surface water resources and nonrenewable groundwater aquifers depleted at unsustainable rates. Water demand competition is also growing among other stakeholders, including those of expanding urban centers, industry, and aquatic ecosystems. These all leave nations with serious water security challenges. Balancing "water security" and "food security" is a big challenge, particularly in countries with limited water resources and fast-growing populations. In this sense, water security means a sustainable water use scenario that maximizes the efficiency of water use by different users, thus ensuring water volumes are allocated for per capita domestic water consumption, ecosystem services, recreation, and aesthetics while meeting the needs of food and fiber production.

Countries in the Arab region face complex and serious challenges. The region is characterized by high population growth rates, large and rapidly increasing food deficits, highly variable income levels both within and between countries, and limited natural resources, particularly arable land and water. Most of the region falls within the arid and semiarid rainfall zones, where 60 % of the total population lives. Therefore, it is a must that countries in the region address and tackle these issues at national, regional, and international levels. This chapter draws largely from the regional report prepared by the Arab Water Council for the 5th World Water Forum held in Istanbul during March 2009. The chapter also benefits from the analyses presented in the background note prepared by the informal consortium of the 6th World Water Forum for the thematic priority "Contribute to Food Security by Optimal Use of Water."

2 Water Security

The Arab region, being one of the most dry and water-scarce regions in the world, has a regional annual average of 1,200 m^3 per capita per year compared to a world average that is close to 7,000 m^3 (Shetty 2006). The most water-scarce countries in the region, such as Saudi Arabia and Jordan, have per capita annual water resources less than 200 m^3. Overall, it is also expected that by 2025, due to population increase, the regional average water availability is projected to be just over 500 m^3 per person per year.

Not only is water scarce, but river flows are highly variable and difficult to manage. Many countries in the region are mining groundwater, a temporary and risky expedient (Fig. 2). Saudi Arabia has paid a heavy price to build up its grain reserves, where 85% of the kingdom's current water use was directed toward agricultural production.[1]

[1] New policy was recently adopted in Saudi Arabia preventing use of groundwater resources in irrigating grains and fodder crops.

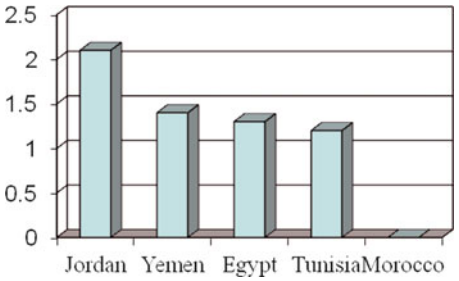


Fig. 2 Value (% of GDP) of groundwater depletion

This water came from nonreplenishable fossil aquifers, which are being sucked dry by the use of 1,000 ton of water to produce every single ton of grain. These challenges are further exacerbated as many of the major water resources in the region are shared between countries lying both within and outside the region. The most significant basins are those of the Jordan, Nile, and Euphrates/Tigris, all of which are subject to contentious riparian issues. Large aquifers underlie North Africa and the Arabian Peninsula but are costly to develop and pose potential problems as agreement on abstractions by several countries is difficult to achieve. One solution adopted by mostly the oil-exporting countries of the region is to desalinate with the Arab world, accounting for about 60% of total global desalination capacity. But this option is still restricted to the major oil-exporting countries.

Deteriorating water quality is also an increasingly serious issue in many areas due to a combination of low river flows, inadequate treatment, agricultural runoffs, and uncontrolled effluent from industry. Seawater intrusion into coastal aquifers is a critical issue in most locations, and water logging and salinization affect several of the major irrigated areas.

Due to its arid climate, most parts of the region experience frequent droughts, and the FAO identified Iraq, Jordan, Morocco, and Syria as the most affected (FAO 2002). Droughts cause a major reduction in agricultural output mainly in rainfed areas but also in irrigated areas where inflow into reservoir will be reduced. Dramatic changes in climatic and hydrologic features in recent years have affected the economies of the region and specifically those of the dry areas where rainfed agriculture is the dominant activity and the only source of income for a majority of the rural population. Droughts of higher frequency and longer duration have had a serious impact on development in several countries of the region, with severe repercussions for economic growth, food security, and poverty alleviation. Droughts affect the lives of the rural poor through decreased agricultural production, death of livestock, and endangered environment, as seen in the loss of soil fertility, loss of species, and the threat of extinction. In the 1994/1995 crop season, a drought season in Morocco, agricultural output of 1995 was 45% lower than the previous year, a non-drought year (ICARDA 2007). Rural landless or small landholders lost 100 million work days in agricultural employment.

Most of the drought-coping strategies implemented by governments of the region have focused on mitigation measures and emergency plans. Governments need to address the issue as a structural phenomenon, inextricably linked with the

Table 1 Annual renewable water resources (RWR)

Source	Unit	Northeast Africa	West Asia	North Africa	Arabian Peninsula	Total region
Precipitation	mm	308	225	102	78	177
Internal RWR	km^3	37.8	176.2	48.1	6.5	268.5
Net incoming flows	km^3	108.7	28.3	11	0	148
Total RWR	km^3	146.5	204.5	59.1	6.5	416.5

Sources: FAO (2008)

Table 2 Expected evolution of irrigation water withdrawals

	Unit	Northeast Africa	West Asia	North Africa	Arabian Peninsula	Total region
2003/2005						
Water requirement ratio	%	57	48	55	50	52
Irrigation water withdrawal	km^3	98.4	126.2	22.2	21.7	268.5
idem as percent of RWR	%	67	62	38	334	64
2030						
Water requirement ratio	%	62	57	60	58	59
Irrigation water withdrawal	km^3	125.1	160.1	29.1	21.5	338.6
Idem as percent of RWR	%	85	78	49	331	81
2050						
Water requirement ratio	%	69	65	64	64	66
Irrigation water withdrawal	km^3	130.2	164.7	30.1	21.7	346.2
Idem as percent of RWR	%	89	81	51	334	83

Sources: FAO (2008)

socioeconomic production system and within the context of scarce, declining, and degraded water resources.

Water needed for agricultural sector to ensure the food needs of the people is diminishing and constitutes the main challenge facing the farming sector. The fast-growing population and rising rates of development make the demands of other water use sectors expand at the cost of water available for agriculture. Addressing the crop production challenge requires to improve water access and therefore increase water storages where needed, as well as expanding irrigated areas and the wider use of management practices that will improve the efficiency of water use, e.g., water-"harvesting" techniques and conservation of soil moisture. In severe water-scarce regions, the effort would have to focus on getting "more crops per drop." This shows the strong relationship between food security and water security as they have become two sides of one coin.

3 Water Productivity

Irrigation water withdrawals in the Arab region are likely to increase by some 29%, from the current 269 to 346 km^3/year in 2050 (Table 1). This increase is modest compared to the more than 50% increase projected in the harvested irrigated area.

Most of this difference will result from the expected improvement in the water requirement ratio (Table 2), leading to a reduction in irrigation water withdrawal per irrigated ha. On average, it is estimated that this ratio for the region was a high 52 % in 2003/2005 and could increase to 66% by 2050.

The problems of agricultural production sustainability may be most acute in some regional countries. For example, in Yemen, the area irrigated by wells rose from 37,000 ha in 1970 to 368,000 in 1996. Government policy strongly encouraged this development with subsidies on fuel and the low interest rates on loans for digging new water wells. Consequently, the extraction from groundwater exceeded recharge by 400% which led to a dramatic fall in water tables. The very significant growth of Yemeni agriculture during the past decade (5.0 % per year) is clearly unsustainable, and this has serious negative implications for the welfare of the country, where roughly 75% of the labor force works in agriculture. In Yemen, and throughout the region, a viable food security strategy will have to pay more attention to using natural resources sustainably.

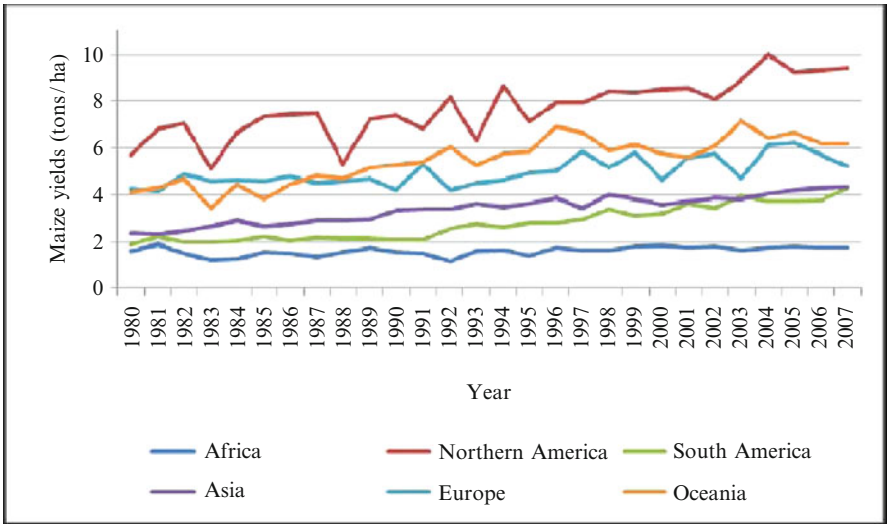
Policies to improve the agricultural production are to maximize the water productivity and are more likely to bring long-term sustainability. Two strategies can be followed to increase the water productivity: (1) increasing crop yield while maintaining constant water use level (dealing with other agricultural inputs) and (2) reducing water consumption and maintaining the yield level. Following these strategies for the water-scarce situation of the arid Arab region, offer the most viable options to increase the agricultural water productivity not the agricultural land productivity.

An example for maximizing the water productivity is the Egyptian policy for cropping pattern shift from high water-consumption crops. This policy is aiming at limiting the area cultivated by rice and sugarcane, the two high water-consumption crops, and encourages the cultivation of alternative crops that have less water consumption. Yet, this policy is not well implemented on rice-cultivation areas due to the high market price of rice comparing to the other crops. The cropping pattern shift policy could be adjusted through applying a system for financial incentives to encourage the farmers to cultivate less water-consumption crops.

Agriculture in the GCC is challenging and in recent years has reoriented itself away from water-intensive crops like wheat to more value-added crops like fruits and vegetables, leaving cereal production to foreign countries and importing stocks to meet demands. Developments in protected agriculture and in the use of marginal waters, such as treated wastewater and saline water, are bringing benefits to present and future possibilities of agricultural production

4 Agricultural Production

A measure of the overall performance of the agricultural sector in the Arab region is how well local yields compare with similar countries and with global averages. As Fig. 3 for productivity highlights, there is a significant gap in crop productivity among the different regions of the world. There are several reasons why yield gaps



Source: FAOSTAT

Fig. 3 Progress in maize yields, 1980–2007 (FAO)

exist. Farmers often do not have sufficient economic means or incentives to adopt yield-enhancing seeds or cropping techniques; they may lack access to information, extension services, and technical skills, and sometimes available technologies have not been adapted to local conditions. Poor infrastructure, weak institutions, and discouraging farm policies can also create obstacles to the adoption of improved technologies at farm level. Solutions lie with public sector investments in infrastructure and institutions and sound policies to stimulate adoption of technologies that reduce costs as well as improving productivity, thus increasing agricultural incomes. Changes in crop management techniques can also help in closing yield gaps.

If the required increase in crop production is compared with the speed of increase over the past period at the global level, it can be observed that the speed of increasing food production has to be significantly faster to cope with the expected need (Schultz et al. 2009). There is a common understanding that 80–90 % of the necessary production increases would have to come from increases in yields and cropping intensity and only 10–20 % from expansion of arable land. It will therefore be of importance to analyze which part of this increase can be achieved by improvements or expansion of rainfed agriculture and which part by irrigated agriculture. This increase in food production will have to be achieved at affordable costs and at affordable prices, especially for the urban poor.

Actions in response to food security may encompass four major *constituents* of the food pathway: (1) increase the supply (productivity enhancement), (2) improve the efficiency of the value chain from producer to consumer, (3) reduce unnecessary demand (excessive consumption and waste) and avoidable degradation (natural resource losses), and (4) enhance the capacity to manage risks and uncertainties derived from crises (environmental, financial, etc.). When investigating the water

Table 3 Production indices and growth rates

	Index (2003/2005 = 100)				Growth rate, % p.a.			
	1991–1993	2003–2005	2030	2050	1990–2005	2005–2030	2030–2050	2005–2050
Total agriculture	69	100	165	216	3.1	1.9	1.4	1.7
All crops	72	100	154	192				
Livestock	65	100	182	254				
Share livestock (%)	36	39	43	45				

Source: FAO: FAOSTAT

implication for these food security actions, one may find an analogous approach: (1) increase the supply (through wastewater reuse, rainfall harvesting, storage, etc.); (2) increase efficiency and productivity of water use; (3) reduce demand (e.g., cropping allocations); (4) enhance capacity of especially rainfed agriculture to cope with climate variability and change; (5) importance of use of facilitation and conflict resolution techniques in discussions among stakeholders.

Intensification of agricultural production to reduce yield gap implies increasing land and water productivity in all agricultural systems (mainly rainfed, rangeland, and irrigated partially or fully). In most countries with agriculture-based economies where rural population is more than 40 % of total population and agriculture has a predominant economical, social, and ecological role, increasing productivity to achieve food security is clearly a priority. The suite of technological options available to producers needs to be as broad as possible, ranging from new plant varieties and animal breeds better adapted to changing conditions to farming systems with improved water-saving technologies, reduction of losses and waste, and natural resource management. New or tailored technologies will be needed to address the problem of rapidly increasing water scarcity and also to reduce postharvest losses.

Agricultural production in Arab countries is projected to grow by more than 60 % between 2001/2003 and 2030 and to more than double by 2050 (Table 3). In spite of this noticeable increase in the volume of production in terms of annual growth rates, this would imply a considerable slowdown from the 3.1 % growth of the period 1990–2005 to 1.9 and 1.4 % over the periods 2005–2030 and 2030–2050, respectively.

The FAO/IIASA3 2002 Global Agro-Ecological Zone (GAEZ) study finds that there is still land with rainfed and irrigated agricultural production potential not yet in use in the region (Table 4). During the next 50 years, arable land could expand by some 11 % (from 76 to 83 million ha), of which some 28 % (from 24 to 29 million ha) would be irrigated. The latter, however, would mean that, by 2050, many of the countries in the region would have exhausted the potential for irrigated land expansion (or exceeded this potential in the case of fossil water use).

Global crises (financial, energy, soaring food prices, trade distortion and speculations, possible impacts of climate change, etc.) make the least developed countries most vulnerable and exposed to high risk of food insecurity. For food supply to be sustainable, action must be taken to arrest the destruction and degradation of the natural resource base. This requires investments to manage the resource base,

Table 4 Crop production and land use in the region

	Rainfed land (mln ha)			Irrigated land (mln ha)			Total land (mln ha)		
	2003/2005	2030	2050	2003/2005	2030	2050	2003/2005	2030	2050
Total harvested land	33.8	40.6	44.7	22.4	30.3	34.3	56.2	70.8	79.0
Arable land	51.9	52.6	53.4	24.2	25.8	28.6	76.1	78.7	82.6
Potential land	152			35			171**		
idem excl. Sudan	59			33			77**		
Arable land as % of potential	34	35	35	64	73	81	43	46	48

Source: FAO: FAOSTAT; AT2050

** total potential land is not equal to the sum of rainfed and irrigable potential land since part of the latter is on rainfed land

improve technical production efficiency (yields), and develop practices that foster sustainable and intensified food production. It implies promoting a sustainable and adaptive way to intensify agriculture production and invest in agricultural water, for small holders. Particular efforts should be made in least developed countries most vulnerable to changes.

Given the suite of currently recognized challenges to achieving food security, it is important to develop strategies to improve the resilience of agriculture to meet the world's needs. Especially in case of rainfed agriculture, climate change may have a significant impact on agricultural production; a goal would have to be to develop strategies to improve the resilience of agriculture to these changes. In the Arab countries, yields of rainfed agriculture could decline between 20 and 40% if no effective adaptation measures are taken. Even if climate change is expected to increase crop productivity of rainfed agriculture in certain areas (thanks to an extended growing season), it is generally agreed among the research community that climate variability and the frequency of extreme weather events will increase even in the near term in all regions. Also, an increasing demand for biofuel feedstock may put additional pressures on global agricultural production. More productive and resilient agriculture requires higher effectiveness with respect to food security goals and increased efficiency, substantial increases in irrigated agriculture, as well as in the use of natural resources and inputs for production.

5 Food Consumption

Between 2002 and 2006, demand for food in the Arab world grew by around 4%, while production rose by 2.6%, leading to an increase in imports to meet domestic consumption. The shortage persisted despite an expansion in the cultivated areas in some Arab countries as a result of reforms aimed at increasing crop.

Food consumption, in terms of kcal/person/day, is the key variable used for measuring and evaluating the evolution of the world food situation. Table 5 shows

Table 5 Per capita food consumption (kcal/person/day)

Region	1969/1971	1979/1981	1989/1991	1999/2001
World	2,411	2,549	2,704	2,789
Developing countries	2,111	2,308	2,520	2,654
Sub-Saharan Africa	2,100	2,078	2,106	2,194
Near East/North Africa	2,382	2,834	3,011	2,974
Latin America and Caribbean	2,465	2,698	2,689	2,836
South Asia	2,066	2,084	2,329	2,392
East Asia	2,012	2,317	2,625	2,872
Industrial countries	3,046	3,133	3,292	3,446
Transition countries	3,323	3,389	3,280	2,900

Source: FAO (2006)

that the world, in general, and the Arab region, in particular (highlighted in green), have made significant progress in raising food consumption per person. In the past three decades to 1999/2001, the Near East/North African countries increased from an average of approximately 2,400 kcal/person/day to almost 3,000 kcal/person/day.

FAO statistics also shows that the percentage of undernourishment of the population in the Arab region is 10%, corresponding to 22 and 33% in south Asia and sub-Saharan Africa, respectively. That might show that the overall present situation in the Arab region is prosperous. However, it has to be noted that countries in the Arab region are the largest grain importers in the world with widening food gaps as a result of high population growth and modest technology adoption rates in cereal. Over the last two decades, net agricultural imports have ranged between US$ 16 and 20 billion. This clearly highlights the high dependency on food imports.

6 Agriculture Trade

Many countries have a high dependence on food imports because they are resource constrained, as the case in the Arab countries. Many countries will continue, depending on international trade, to ensure their food security (Fig. 4). The volume of food exported (green) or imported (yellow-red) is expressed as a percentage of total consumption in each country and represents, for the food-importing country, their relative dependence on external sources of food (WWF6 2011).

While it is a long way for Arab countries to reach high levels of food security, there is an indication that agricultural trade liberalization could have an important role to play to achieve this important objective sought in the region. Both the domestically implemented structural reforms currently conducted in the field of agriculture and the WTO negotiations under way aim at substantial improvements in the environment in which farmers and consumers of agricultural and food products operate by reducing the trade-distorting mechanisms currently in place. The outcome of domestic reforms, the free trade agreements with the EU and other partners, and the WTO negotiations will effectively form the boundaries within

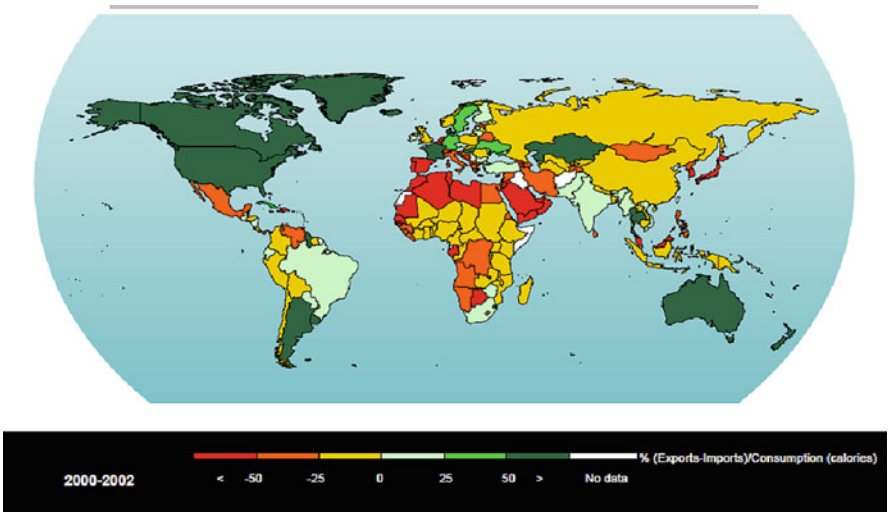


Fig. 4 Average net trade in food in the years 2000–2002

which agricultural and trade policies for Arab countries and their major trading partners can develop for the next few decades.

Unilateral decisions by countries to restrict exports tend to aggravate the situation and result in increased speculation. Several factors point to the risk of growing price volatility. Low-income food deficit countries need to reduce their vulnerability to international market shocks. Price volatility issues and the need for a better governance of global commodity markets and food security system have attracted recent attention. Steps to prevent future food crises include establishing effective social safety nets, measures to tackle price volatility including appropriate use of food reserves, significant investments in modernization of irrigation and drainage systems (including both technology and management techniques aiming fair sharing between users), as well as the installation of new systems, anticipation of possible impacts of climate change, especially with respect to rainfed agriculture, productivity-enhancing and fair-sharing governance mechanisms for small-holder farmers, and new institutional arrangements.

7 Agricultural Socioeconomic Dimension in Rural Economy

While agriculture and the rural economy are important elements in the Arab region, their contribution to the general domestic product (GDP) is low and has been declining in the recent years. Table 6 shows that agriculture, even in Syria, which has the highest share of contribution to GDP in the region, contributes only 24%. For instance, agriculture in Jordan contributes a mere 2% to GDP. Despite that, agriculture is by

Table 6 Water use and GDP contribution of agriculture and industry

	Agriculture share		Industry share	
Country	Water use (%)	GDP (%)	Water use (%)	GDP (%)
Algeria	69	12	15	60
Egypt	88	14	8	34
Iran	92	19	2	22
Jordan	75	2	3	n/a
Lebanon	72	12	4	22
Morocco	93	16	3	32
Saudi Arabia	90	7	1	n/a
Syria	96	24	2	30
Tunisia	87	12	3	29
Yemen	96	15	1	48

Source: AWC (2009)

far the dominant user of water, where in some countries like Morocco, Syria, and Yemen, agriculture consumes close to 100% of all available water resources. The wide gap between water use and GDP contribution for agriculture is highlighted even more when contrasted to the industrial sector (Table 6). For example, Algeria uses 69 and 15% of its water in agriculture and industry, but their contributions are 12 and 60% of GDP, respectively. This is the case in each country; the contribution of GDP is always less from agriculture when compared with the industrial sector contribution.

Therefore, from a narrow macroeconomic perspective, rationale of justifying the allocation of water to agriculture over industrial and other sectors is weak. Thus, as countries confront the water crisis situation, there will no doubt be increasing pressure to allocate water away from agricultural to industrial and municipal uses as well as to increase water efficiency within the agricultural sector. Some countries in the region such as Tunisia, Morocco, and Jordan have already begun addressing the issue of water reallocation where others have not.

However, from a broader development point, it is important to note that agriculture claims the largest share of the work force in the region with a high proportion of the poor depending on the sector for the livelihoods. Region-wide, 88% of economically active population works in the agriculture sector. In some countries such as Egypt and Morocco, more than 90% of the economically active population is agricultural workers. Thus, despite the small contribution to GDP, agriculture is still the key to development in many developing regions including the region. Based upon that and to solve this paradox, since water will still be the main input in agriculture, the focus has to be on how to improve efficiencies and reduce overall usage through new technologies and research.

After the deep recession faced by the region in the 1980s, wide-ranging economic reforms have been implemented in the 1990s, aimed at tightening demand, liberalizing trade, and improving the regulatory framework in which the process of development was being implemented. Those reforms gave a significant boost to growth with an average annual GDP growth estimated at around 3% (Shetty 2006) and have started putting the foundations of a market-based economy where the private sector

is encouraged to play a more prominent role. Despite these signs of economic recovery, the region still suffers from the burden of an inefficient public sector, high levels of unemployment, substantial poverty, slow steps in global and regional integration, and a mounting pressure on its natural resources as a result of population growth, urbanization, and demand changes. All these challenges are related in one way or another to the performance of agriculture, a sector still contributing to growth and employment. While some of these challenges have directly or indirectly hindered the development of the sector, others are the result of its inability to achieve substantial jumps in productivity hampered by limited extension services and poor investment climate to support the adoption of new technologies. The limited progress achieved in the agricultural sector has important implications with respect to the fight against poverty which has to be considered as an important dimension of the development agenda in the region.

8 Water Pricing Policy

Overall mismanagement of various policies dealing with both input and output prices in agriculture contribute to rural poverty in a substantial way. When prices do not reflect the actual scarcity and are artificially set, overconsumption and undersupply tend to occur. Heavy subsidies for producers of "strategic crops" such as wheat, sugar, oilseeds, beef, and dairy products, as well as on irrigation water are common pricing policies in the region. Producer subsidies for these "strategic crops" are often justified by a policy of promoting self-sufficiency but by encouraging the production of crops which has little comparative advantage; public support is used inefficiently. Furthermore, targeting mechanisms are generally weak, and therefore, subsidies tend to benefit middle- and high-income producers rather than poor ones who have limited access to markets or state purchases.

Agriculture might have needed subsidies and protection to attain some economies of scale in production and marketing, but it has now become a more mature sector that needs to improve efficiency further, become more competitive in a more open trade environment, and less reliant on subsidies. Reduction of some subsidies, and possibly phasing out other subsidies, such as for irrigation, would reduce the rate of depletion of aquifers to a more sustainable level and encourage efficiency gains in the sector by promoting a shift toward higher value-added crops.

When the price paid for a commodity reasonably reflects the true market price, this forces efficient distribution. In other words, subsidized water leads to a waste in agricultural water. The primary alternative to quantity-based allocation of water is incentive-based allocation, either through volumetric water prices or through markets in transferable water rights. The latter is not a popular policy in most of the Arab countries, although informal water markets exist as in the case in Yemen. Volumetric water pricing is more acceptable in the countries of the region rather than from a cost recovery perspective. Empirical evidence shows that farmers are price responsive in their use of irrigation water. The four main types of responses to higher water prices are use of less water on a given crop, adoption of water-conserving

Table 7 Per capita food consumption (kcal/person/day) (FAO 2006)

Region	2015	2030	2050
World	2,950	3,040	3,130
Developing countries	2,860	2,960	3,070
Sub-Saharan Africa	2,420	2,600	2,830
Near East/North Africa	3,080	3,130	3,190
Latin America and Caribbean	2,990	3,120	3,200
South Asia	2,660	2,790	2,980
East Asia	3,110	3,190	3,230
Industrial countries	3,480	3,520	3,540
Transition countries	3,030	3,150	3,270

Source: AWC (2009)

irrigation technology, shifting of water applications to more water-efficient crops, and change in crop mix to higher-value crops. However, this has to be balanced against the fact that for most countries in the world, water price acceptability in agriculture is very low, and the Arab region is no exception.

9 Future Expectations

Table 7 shows the estimated per capita food consumption up to 2050. Again, it shows that countries in the Arab region will maintain the progress that they already made in the last decades and will reach almost 3,200 kcal/person/day, which is a good progress compared to other similar regions of the world.

In terms of water, withdrawals could increase from the current 269 to 346 km^3/year in 2050. This increase is the modest compared to the more than 50 % increase projected in the harvested irrigated area. Most of this difference will result from the expected improvement in the water requirement ratio, leading to a reduction in irrigation water withdrawal per irrigated ha. On average, it is estimated that this ratio for the region was a high 52 % in 2003/2005 and could increase to 66 % by 2050.

Taking into account the expected impacts of climate change by 2050 (through the combined effect of changes in precipitation and in evapotranspiration), the availability of renewable water resources will decrease while, at the same time, irrigation water withdrawals would need to increase, thus severely worsening the situation of water scarcity in the region.

10 Concluding Remarks and Recommendations

- Food security is high on the political agenda of the last few years in Arab countries.
- Countries in the region have made a great progress in increasing the per capita food consumption to almost 3,000 kcal/person/day. It is expected to reach 3,200 kcal/person/day by 2050. However, there is clearly a high dependency on food imports.

- Agriculture's contribution to the GDP is low and has been declining in the recent years; however, agriculture claims the largest share of the work force in the region with a high proportion of the poor depending on the sector for the livelihoods.
- For years, finding enough water for people meant finding more water to use. Today, and into the future, the way forward is to find ways to use water in a more sustainable manner across all sectors to meet the growing demands.
- Reforms in agricultural policy and drought management are critical especially with respect to the rural poor. Countries have to review their approach to drought management because of a higher degree of vulnerability to drought in the region. The careful management of water resources will become increasingly important in mitigating the impact of drought on the economies of the region in the future.
- Technical innovations and water sector reforms need to be accompanied by agricultural sector reforms. Empirical evidence indicates that water sector reforms in the absence of associated reforms in the agricultural sector will be unproductive and unsustainable.
- Significant investments in modernization of irrigation and drainage systems and enhancing rainfed agriculture (including both technology and management techniques) contribute to future food crises.
- Subsidies and incentives played a critical role in leading agricultural development and growth in the region, but they have also resulted in environmentally unsustainable and inefficient uses of a scarce resource. They have led to market distortions, excessive use of groundwater for irrigation, and a high fiscal burden. The primary alternative to quantity-based allocation of water is incentive-based allocation, either through volumetric water prices or through markets in transferable water rights.
- Greater integration with world markets will become essential; likewise will investments in human capital, natural resource management, and research and technological development. Countries in the region should also have more integration and complement each other to reach self-sufficiency and minimize food imports from outside the region and maximize the use of their resources.
- There seems to be a convergence of actions in the response to food security needs. The enabling environment to make these changes happen needs to be provided through policy, institutions (capacity building), private partnerships, fare trades, and other measures.

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