

# Agriculture

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## I. INTRODUCTION

Agriculture comprising irrigated and rain-fed farmland is a complex activity with a multifunctional character encompassing economic, social, and environmental dimensions. The combination of agriculture and rangelands and livestock husbandry has played a key role in producing food and other commodities for human survival and development throughout the history of mankind. Today the ability of humans to sustain agricultural functions has come under close scrutiny triggered by population growth and increased pressure on limited resources.

Perhaps there is no region in the world today where agriculture faces daunting challenges to the extent that is the case in the Arab region. Population growth in Arab countries is among the highest in the world. Average per capita natural freshwater resources, only about one-tenth of the world average, is already at critical levels in most Arab countries. Agricultural productivity of principal food commodities such as cereals is the lowest in the world. Past agricultural policies and practices have compounded soil erosion,

land degradation, water logging, soil salinity, and water pollution. Furthermore, climate change disruptions are likely to inflict severe damage on agricultural productivity and water availability in the Arab region.

The advent of the recent food crises of 2007-2008 has generated renewed interest by Arab countries in promoting agriculture for food security. This adds to pressures on agriculture to combat poverty and provide economic opportunities in rural areas and redirect some of its share of clean water to meet the rising demand for urban and industrial water use. Adopting a business-as-usual scenario for agriculture in the Arab region is untenable and could eventually be detrimental to the long-term sustainability of agriculture. Changes in agricultural policies and practices are needed to develop agriculture without undermining its role as a provider of environmental services.

In this chapter we will highlight the implications of unsustainable agriculture on Arab economies, and suggest a set of enabling conditions required to facilitate the transition to a green and sustainable agricultural sector in the Arab world.



TABLE 1 CONTRIBUTION OF AGRICULTURE TO GDP

| Country                      | Agricultural GDP (Million \$) |               |                | Contribution of Agriculture to GDP (%) |             |            |
|------------------------------|-------------------------------|---------------|----------------|--|-------------|------------|
|                              | 1990                          | 2000          | 2008           | 1990                                   | 2000        | 2008       |
| Algeria                      | 5,334                         | 4,600         | 11,197         | 9.6                                    | 8.4         | 6.6        |
| Egypt                        | 4,675                         | 15,474        | 20,520         | 16.0                                   | 15.5        | 12.6       |
| Iraq                         | 16,467                        | 1,206         | 4,477          | 21.4                                   | 5.8         | 4.1        |
| Morocco                      | 3,933                         | 4,917         | 11,202         | 15.5                                   | 13.3        | 13.1       |
| Saudi Arabia                 | 6,713                         | 9,326         | 10,947         | 6.4                                    | 4.9         | 2.3        |
| Sudan                        | 3,062                         | 4,796         | 17,922         | 29.3                                   | 35.7        | 29.3       |
| Syria                        | 3,949                         | 4,667         | 10,741         | 27.4                                   | 24.7        | 20.4       |
| <b>Sub-Total</b>             | <b>44,133</b>                 | <b>44,986</b> | <b>87,006</b>  | <b>13.9</b>                            | <b>10.3</b> | <b>7.8</b> |
| <b>Other Arab countries*</b> | <b>7,197</b>                  | <b>11,406</b> | <b>16,382</b>  | <b>5.8</b>                             | <b>4.7</b>  | <b>2.1</b> |
| <b>Total</b>                 | <b>5,330</b>                  | <b>56,392</b> | <b>103,388</b> | <b>11.6</b>                            | <b>8.3</b>  | <b>5.4</b> |

\* Bahrain, Djibouti, Jordan, Kuwait, Lebanon, Libya, Mauritania, Oman, Qatar, Somalia, Tunisia, United Arab Emirates, and Yemen  
Source: AFESD et al., 1993; GSLAS et al., 2009

## II. IMPLICATIONS OF PAST AND CURRENT AGRICULTURAL PRACTICES AND POLICIES

Agriculture is an important sector in most Arab economies as a contributor to gross domestic product (GDP) and employment, and as a main source of income generation and livelihood for the majority of the rural population. The sector also plays a key role in maintaining public health and nutrition and in providing environmental products and services.

## A. ROLE OF AGRICULTURE IN ARAB ECONOMIES

### i. Agricultural GDP

Since most Arab countries are located in arid and semi-arid areas, their agricultural production has been vulnerable to the effects of weather constraints and recurrent droughts. Variations in arable land and water resources among Arab countries affect to a large extent the role of

TABLE 2 CULTIVATED AREA AND VALUE OF AGRICULTURAL OUTPUT (2008)

| Country                      | Cultivated Area (1,000 Hectares) | Agricultural GDP (Million \$) | Cultivated Area (%) | Agricultural GDP (%) |
|------------------------------|----------------------------------|-------------------------------|---------------------|----------------------|
| Algeria                      | 4,861.49                         | 11,197                        | 9.10                | 10.83                |
| Egypt                        | 3,541.52                         | 20,520                        | 6.63                | 19.85                |
| Iraq                         | 3,826.25                         | 4,477                         | 7.16                | 4.33                 |
| Morocco                      | 6,983.90                         | 11,202                        | 13.07               | 10.83                |
| Saudi Arabia                 | 971.76                           | 10,947                        | 1.82                | 10.59                |
| Sudan                        | 18,783.66                        | 17,922                        | 35.16               | 17.33                |
| Syria                        | 4,610.66                         | 10,741                        | 6.63                | 10.39                |
| <b>Sub-total</b>             | <b>43,579.24</b>                 | <b>87,006</b>                 | <b>81.58</b>        | <b>84.15</b>         |
| <b>Other Arab countries*</b> | <b>9,840.46</b>                  | <b>16,382</b>                 | <b>18.42</b>        | <b>15.85</b>         |
| <b>Total</b>                 | <b>53,419.70</b>                 | <b>103,388</b>                | <b>100.00</b>       | <b>100.00</b>        |

\* Bahrain, Djibouti, Jordan, Kuwait, Lebanon, Libya, Mauritania, Oman, Qatar, Somalia, Tunisia, United Arab Emirates, and Yemen  
Source: AOAD, 2009a; Table 1

TABLE 3 AGRICULTURAL LABOR IN SELECTED ARAB COUNTRIES

| Country              | Population (1,000) |                | Total Labor (1,000) |                | Agricultural Labor (1,000) |               | Agricultural Labor (%) |           |
|----------------------|--------------------|----------------|---------------------|----------------|----------------------------|---------------|------------------------|-----------|
|                      | 1990-1992          | 2005-2007      | 1990-1992           | 2005-2007      | 1990-1992                  | 2005-2007     | 1990-1992              | 2005-2007 |
| Algeria              | 25,667             | 33,480         | 6,160               | 29,264         | 1,109                      | 2,428         | 18                     | 19        |
| Egypt                | 53,923             | 71,373         | 16,716              | 12,780         | 7,021                      | 8,491         | 42                     | 29        |
| Jordan               | 3,784              | 5,599          | 870                 | 2,237          | 87                         | 148           | 10                     | 7         |
| Lebanon              | 2,789              | 3,917          | 836                 | 1,495          | 117                        | 37            | 14                     | 2         |
| Mauritania           | 2,067              | 3,054          | 682                 | 1,558          | 471                        | 765           | 69                     | 49        |
| Morocco              | 25,018             | 31,570         | 8,258               | 13,612         | 3,798                      | 5,009         | 46                     | 37        |
| Oman                 | 1,580              | 2,610          | 442                 | 1,142          | 217                        | 339           | 49                     | 30        |
| Saudi Arabia         | 15,706             | 23,680         | 4,555               | 8,464          | 2,186                      | 532           | 48                     | 6         |
| Sudan                | 25,927             | 36,311         | 9,074               | 14,421         | 6,534                      | 7,529         | 72                     | 52        |
| Syria                | 12,537             | 18,676         | 3,260               | 6,849          | 717                        | 1,560         | 22                     | 23        |
| Tunisia              | 8,233              | 10,127         | 2,470               | 3,007          | 642                        | 556           | 26                     | 18        |
| United Arab Emirates | 1,630              | 4,272          | 815                 | 2,809          | 41                         | 133           | 5                      | 5         |
| Yemen                | 12,633             | 22,661         | 3,158               | 6,809          | 1,990                      | 2,748         | 63                     | 40        |
| <b>Total</b>         | <b>191,494</b>     | <b>267,330</b> | <b>57,295</b>       | <b>104,592</b> | <b>24,930</b>              | <b>30,275</b> | <b>44</b>              | <b>29</b> |

Source: Computed and compiled from data in GSLAS et al., 2009; Other various Unified Arab Economic Reports

agriculture in each country's economy.

Despite an increase in the value of agricultural production in past years, the average contribution of agriculture to Arab countries' GDP experienced a sharp decline from 11.6% in 1990 to 5.4% in 2008 (AFESD et al., 1993; GSLAS et al., 2009), with a wide variation in the contribution of agriculture to GDP among Arab states, as indicated in Table 1.



Table 1 indicates that seven countries in the region (Algeria, Egypt, Iraq, Morocco, Saudi Arabia, Sudan, and Syria) accounted for 85% of total agricultural GDP in 2008. The same countries accounted for 82% of actual cultivated area in 2008 (AOAD, 2009a), as indicated in Table 2.

It is evident from Table 2 that a country's share in total cultivated area does not presume a similar share in the value of agricultural output. The most striking disproportionateness between the two variables is in Egypt and Saudi Arabia where the share of each to the value of total agricultural product is way above that of its share in cultivated area. The case is opposite in Sudan, where about 35% of the total cultivated area contributes only about 17% to the total value of agricultural product in the region. This wide variation is an outcome of the complexity of agriculture whose output is conditional upon the quantity and quality of numerous inputs such as soil, irrigation, fertilizers, mechanization, and labor skills, in addition to extension services, technology, and weather conditions.

The contribution of agriculture to the GDP of Arab countries as a group is modest, yet it remains



an important economic activity contributing 10-30% to GDP in seven countries, namely, Egypt, Mauritania, Morocco, Sudan, Syria, Tunisia, and Yemen.

In general, agricultural performance in terms of annual growth in most Arab countries surpassed that of the world average of 2% and 2.5% for the two periods 1990-1992 and 2005-2007, respectively, with agricultural growth in Algeria, Egypt, Syria, Tunisia, and the United Arab Emirates (UAE) exceeding world growth and that achieved by most other regions in the world (World Bank, 2010). Comparing growth in agriculture between countries and across regions is not necessarily a measure of performance of a complex economic activity whose output is dependent on interactions among a host of inputs as already pointed out. Even the value added or total factor productivity (TFP) growth remains a deficient indicator of agricultural performance without duly accounting for the impact of agricultural practices on environmental aspects, including soil erosion, land degradation and desertification, and biodiversity loss. Such agricultural externalities are exerting increasing pressure on agricultural limited resources, with short and medium-term benefits achieved at the expense of long-term agricultural sustainability.

Agriculture has a strong and demonstrable record in development as a lead sector and an engine for overall growth in agricultural-based countries (World Bank, 2008). In the past, the neglect of agriculture in most developing countries due to underinvestment, lack of incentives, and distortive policies has hampered the sector from playing a leading role in economic growth. The recent global food and financial crises have revived interest in agriculture as a precursor to poverty reduction, food security, and economic growth in general. Arab and other developing countries have ranked agriculture at the top of their development agendas to make it a lead sector for growth and development.

It is important to note that agricultural GDP figures for Arab countries, already presented in Table 1, are apparently overstated because externalities associated with the economic costs of agriculture-related environmental degradation are not factored in. For example, the estimated

TABLE 4

## SOME AGRICULTURAL INDICATORS FOR ARAB COUNTRIES\*

|   | 1990-1992 | 2005-2007 |
|---|-----------|-----------|
| Population (1,000)                      | 191,494   | 267,330   |
| Total Labor (1,000)                     | 57,295    | 104,592   |
| Agricultural Labor (1,000)              | 24,930    | 30,275    |
| Agricultural Labor (%)                  | 44        | 29        |
| Value Added per Agricultural Labor (\$) | 1,985     | 2,332     |
| Agricultural GDP (Million \$)           | 49,487    | 70,586    |
| Per Capita Agricultural GDP (\$)        | 258       | 264       |

\* 13 Arab countries (Algeria, Egypt, Jordan, Lebanon, Mauritania, Morocco, Oman, Saudi Arabia, Sudan, Syria, Tunisia, United Arab Emirates, and Yemen). Values in constant \$ 2000  
Source: Population and Labor figures compiled and computed from data in GSLAS et al., 2009 and other various Unified Arab Economic Reports. Value added per agricultural labor from World Bank, 2010

total cost of environmental degradation in Morocco was 3.7% of GDP in 2000, with water, agricultural land, and rangeland degradation accounting for 41% of the GDP loss (Sarraf and Jorio, 2010). This is a significant loss arising mainly from unsustainable land and water resource management practices, which if not reversed will lead to further degradation over time. This would endanger the sustainability of agriculture with serious consequences on food security, poverty alleviation, and people's livelihoods.



TABLE 5

**TOTAL FACTOR PRODUCTIVITY  
(AVERAGE ANNUAL PERCENTAGE CHANGE)**

|              | 1961-1981 | 1981-2000 |
|--------------|-----------|-----------|
| Algeria      | -0.8      | 3.2       |
| Egypt        | 1.1       | 2.1       |
| Iraq         | -3.1      | -1.0      |
| Jordan       | -3.4      | 1.6       |
| Lebanon      | 3.8       | 2.7       |
| Libya        | 4.6       | 4.5       |
| Morocco      | 1.7       | 2.9       |
| Saudi Arabia | -3.3      | 4.8       |
| Sudan        | -0.7      | 2.0       |
| Syria        | 1.4       | 0.3       |
| Tunisia      | 3.3       | 2.0       |
| Yemen        | -10.3     | 2.1       |

Source: FAO, 2005a

**ii. Employment**

Agriculture is a major source of employment in Algeria, Egypt, Mauritania, Morocco, Oman, Sudan, Syria, Tunisia, and Yemen, where the average percentage of men and women working in agriculture ranged between about 20% and 50% of the total labor force over the period 2005-2007 (GSLAS et al., 2009), as indicated in Table 3.

It is important to note that the decline in the contribution of agriculture to GDP has been accompanied by a similar decline in the average percentage of agricultural labor from 44% to 29% in the selected Arab countries over the two periods 1990-1992 and 2005-2007, respectively, as can be deduced from Table 3. This had significantly enhanced the productivity of agricultural workers in these countries with the value added per worker rising from about \$1,985 over the period 1990-1992 to about \$2,332 over the period 2005-2007 (World Bank, 2010), as indicated in Table 4.

A comparison of average value added per worker with that of agricultural GDP in Arab countries reveals a considerable difference between their average growth rates over the two periods shown in Table 4. While figures on value added per agricultural worker embodied an average growth rate of about 1.4% per annum over the period from 1990-1992 to 2005-2007, agricultural GDP grew at almost double this rate (about

2.7%) over the same period. This wide divergence between the two growth rates signifies the effect of expansion of the cultivated area associated with agricultural sector reforms.

Analysis of data gathered on total factor productivity (TFP) in developing countries include the TFP of agriculture in a number of Arab countries over two periods, as indicated in Table 5.

Table 5 demonstrates that TFP has improved substantially in most Arab countries during the period 1981-2000. Another study focused on the Middle East and North Africa (MENA) region (19 Arab countries and Iran) shows that the TFP index (taking 1961 as the base year for growth rate changes in TFP) increased sharply from an average growth of 0.1% annually during the period 1965-1984 to an average growth of 2% annually over the period 1985-2006 (IFPRI, 2010). This improvement in TFP growth during the second period corresponded roughly with agricultural policy reforms initiated by most Arab countries in the mid 1980s. During the pre-reform period many governments in the region were pursuing food self-sufficiency goals, particularly in cereals, and therefore farmers and agro-food processors were supported by a variety of measures, including subsidies for various inputs, and adopting a trade policy with extensive use of tariffs and non-tariff barriers, giving rise to distorted patterns of production, trade, and reduced economic efficiency (IFPRI, 2010).

**iii. Impact of Subsidies**

Arab agricultural policies are characterized by blanket subsidies. Many Arab countries offer their farmers guaranteed prices for their crops. While subsidies lower the price of fertilizers, pesticides, irrigation water, and fuel for farmers, "such untargeted subsidies are not focused on the poor, have a fiscal cost, reward low-value cropping, and encourage the overuse of water" (Yamouri, 2008).

**iv. Impacts of Trade**

In addition to the implications of agricultural practices and policies on GDP and income, inappropriate trade policies can have serious economic, social, and environmental consequences.

## CONSERVATION AGRICULTURE

### Boghos Ghougassian

For 25 years the vast fruit orchards of Gaby & Seto Company in the Kefraya area of West Bekaa, Lebanon, have been managed by the application of conservation agriculture (CA) principles. Five types of fruit trees are mainly grown, namely: apples, pears, plums, nectarines, quince, and their varieties.

The two main CA principles, minimal soil disturbance and permanent soil cover, are practiced in a 120-hectare plot of land. Mr. Seto, the General Manager of the company, indicates that "CA is a management technique for us that combines profitable agricultural production with environmental concerns and sustainability, and this has been proven to work for 25 years in our fruit plantations."

On the flat plots, 60 hectares in size, no tilling takes place and flood irrigation is practiced in the summer season. The grass covering the surface is not tilled or killed by herbicides. Rather, the grass is just cut and left in its place. This measure lowers evapo-transpiration rates and reduces irrigation water requirements by 25%, compared with conventionally tilled land. The accumulated grass acts like a carpet on the ground, protecting fruit from damage upon falling. About 75% of those fallen pieces of fruit are marketed as second grade fruit, generating reasonable revenue from sales. Without the grass cover, the falling fruit would have been damaged and spoiled within a few hours. The dried accumulated grass acts as mulch and eventually turns into an organic soil conditioner, a fodder for soil microorganisms. Due to the presence of a grass cover, the water penetration in the soil is improved. And during the rainy season the cover grass holds precipitated rainwater, protecting the land from flooding and the soil from erosion.

The other half of the fruit orchards, also 60 hectares in size, is located on hills or inclined plots of lands. There a drip irrigation system is used, taking care to water the area located directly under the fruit tree. This method of irrigation protects the soil from water erosion. Grass growing under young trees, 10 years old or younger, is cut manually and left under the trees. For trees older than 10 years, grass is eliminated by spraying with safe agrochemicals. In this hilly area, minimum tillage is practiced at a rate of one tilling per year and only after the rainy season. For these older trees, no soil erosion problems have been encountered.



The fruit orchards are properly managed with high quality agricultural inputs. For irrigation, unpolluted water is withdrawn from 4 wells replenished by the snowmelt of the nearby Barook Mountains. Only high quality agrochemicals are utilized. For instance, pesticides that are known to be safe for bees are used. Beekeepers are encouraged to bring in more than 300 beehives in the orchards of the company. Beekeepers claim that at the orchards of Gaby & Seto Company, bees proliferate and beehives increase in number, thus boosting honey production significantly.

The resulting fruit products are of distinctive taste and quality, with 80 to 95% of them marketed as first grade fruit. Because of those traits, the demand for the company's products is competitively high.

The adoption of conservation agriculture principles has enabled this orchards company to protect its land assets and boost its business bottom line in a sustainable manner. The company uses less labor, less irrigation water, and less machinery and fuel, while protecting the soil from erosion. These advantages have resulted in lower production costs and higher income.

Conservation agriculture provides a model for profitable agriculture and environmental gains, while consumers benefit from high quality fruit products of distinctive taste.

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Arab countries are net importers of agricultural products and run a large trade deficit in agricultural commodities. They seek to promote production of agricultural commodities to meet local demand and for export. They have made efforts to liberalize trade, but “without the right environmental policies in place, trade liberalization could have negative consequences for developing countries” (UNEP, 2005). Prevailing agricultural practices and policies in the Arab region have caused environmental degradation and biodiversity loss. Unless policy reforms for more sustainable patterns of agriculture are introduced, the contribution of agriculture to the economic and social wellbeing of the rural population will be seriously affected. Policies and incentives to optimize the use of agro-chemicals and encourage sustainable and organic farming practices are necessary to achieve agricultural sustainability and enhance the role of the sector as a supplier of safe and healthy food for local consumption, as well as for accessing external markets, which require compliance with regulations and standards of agricultural products, particularly with respect to food safety and the environment.

#### v. Agricultural investments

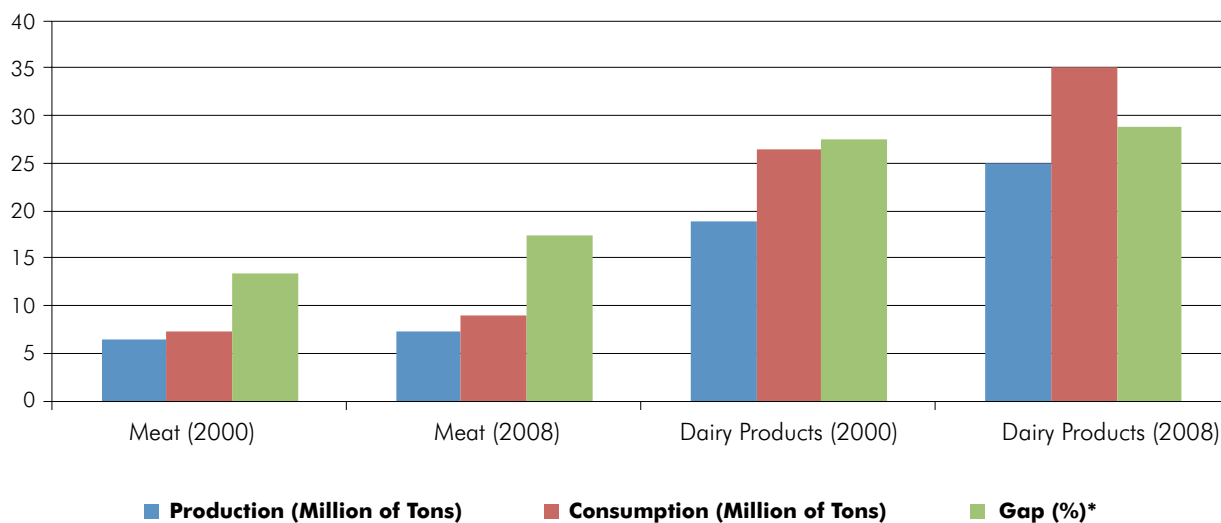
Despite its importance as a lead sector for economic growth and rural development “agriculture has not been used to its full potential

in many countries because of anti-agriculture policy biases and under investment” (World Bank, 2008). Over the past five decades, most Arab and other developing nations financed investments from their own resources, in addition to assistance provided by donors and international development institutions. However, neglect of the sector is evidenced by the sharp decline in official development assistance (ODA) to agriculture during the last three decades due to a complex set of underlying reasons.

The underlying causes of neglect in the Arab agricultural sector mirror those highlighted by the World Bank for explaining the dramatic decline in ODA for financing agricultural investments in developing countries. In general, they include past agricultural investments in an environment of falling international commodity prices, competition for ODA from social sectors, opposition from donor country farmers to supporting agriculture in their major export markets, and opposition from environmental groups to agriculture because of its contribution to natural resource depletion and pollution (World Bank, 2008). Implementation challenges of spatially dispersed programs with weak governance are also cited as contributing to this neglect.

Globally, official development assistance (ODA) for agriculture in developing countries

FIGURE 1 SELF-SUFFICIENCY GAP IN MEAT AND MILK IN ARAB COUNTRIES (2000-2008)



\* Net imports as percentage of consumption.

Source: AFESD and KFAED, 2010



## EARLY DROUGHT WARNING SYSTEM IN MOROCCO

When a drought occurs nationwide, the policy applied so far consists of setting up a national drought plan to combat the deleterious consequences of drought. The main components of the plan are designed to assist rural populations in solving the problems associated with: (i) drinking water, (ii) livestock protection, (iii) jobs creation, (iv) agricultural credit debt relief, and (v) public awareness. This is typically a crisis-management oriented approach whose cost is tremendous in terms of public spending, time, and human resource needs.

To our best knowledge, Morocco is the only country in the Arab world that has an institution charged with drought mitigation and early drought warning. In 2001, the National Drought Watch (NDW) was created within the Ministry of Agriculture, Rural Development and Fisheries. As a result of a ministerial decision, it was located physically in an academic institution allowing multidisciplinary collaboration, giving it some neutrality with regard to policy pressures.

The NDW is designed to operate as an institutional network with a Central Management Unit and Regional sub-units, thus benefiting from existing structures, particularly of scientific human resources both centrally and regionally. It has a structure involving regional centers in research institutions, and a framework for working groups that can include and be led by a number of partner institutions. For example, the impressive capacity and track record of the National Meteorological Office (DMN) is an outcome of the multidisciplinary and policy oriented work of the National Drought Watch. The same observation applies to the Royal Centre for Remote Sensing of Morocco, which has a good working program with NDW.

*Ameziane, T.E., Alaoui, S.B., Imani, Y., Belhamd, A., Belghiti, M., Ezzine, H., Ouassou, A., Sibou, T., Zyad, M (2007). Integrated Water and Drought Management in Morocco. Contribution of the Medroplan Team/National Drought Observatory, Medroplan Project*

fell dramatically over the last three decades. Agriculture's share of ODA dropped from as high as 18% in 1979 to 3.5% in 2004, and also declined in absolute terms (measured in 2002 constant prices) from about \$8 billion in 1984 to \$3.4 billion in 2004 (World Bank, 2008). A paper on ODA directed to agriculture was produced by the Agriculture and Natural Resources Team of the UK Department for International

Development (DFID) in November 2004 shows ODA flows from the Organization for Economic Cooperation and Development (OECD) and multilateral financial institutions to world regions, as indicated in Table 6.

The figures in the Table above show that the Middle East and North Africa region witnessed the sharpest decline in agricultural ODA in absolute

TABLE 6 REGIONAL DISTRIBUTION OF ODA TO AGRICULTURE, 1980-2002 (CONSTANT 2002 US\$ MILLION)

| Region                              | 1980   | (% of Total) | 1985   | (% of Total) | 1990   | (% of Total) | 1995   | (% of Total) | 2002   | (% of Total) |
|-------------------------------------|--------|--------------|--------|--------------|--------|--------------|--------|--------------|--------|--------------|
| <b>Sub-Saharan Africa</b>           | 1450.0 | 25.2         | 1872.8 | 30.2         | 2035.2 | 40.7         | 1108.4 | 41.5         | 713.6  | 37.4         |
| <b>Middle East and North Africa</b> | 553.7  | 9.6          | 251.3  | 4.1          | 256.4  | 5.1          | 199.4  | 7.5          | 60.5   | 3.1          |
| <b>Far East Asia</b>                | 944.0  | 16.4         | 882.2  | 14.2         | 1064.2 | 21.3         | 636.4  | 23.8         | 479.8  | 25.1         |
| <b>South and Central Asia</b>       | 2593.4 | 45.0         | 2608.8 | 42.1         | 1400.9 | 28.0         | 632.8  | 23.7         | 442.2  | 23.2         |
| <b>South America</b>                | 220.0  | 3.8          | 580.5  | 9.4          | 238.9  | 4.8          | 95.8   | 3.6          | 213.9  | 11.2         |
| <b>All developing regions</b>       | 5761.1 | 100.0        | 6195.6 | 100.0        | 4995.6 | 100.0        | 2672.8 | 100.0        | 1910.0 | 100.0        |

Source: DFID, 2004

TABLE 7

POPULATION AND RURAL POPULATION  
IN ARAB COUNTRIES

|                              | 1981  | 1990  | 2008  |
|------------------------------|-------|-------|-------|
| <b>Population (Millions)</b> | 171.5 | 232.2 | 344.1 |
| <b>Rural Population (%)</b>  | 56    | 50    | 45    |

Source: World Bank, 2010

and relative terms. Its share dropped drastically to only US\$60.5 million or 3.1% of total flows in 2002. Nevertheless, whatever their level is, ODA resources are limited and competition for them and for public funds from other social sectors such as health and education is mounting.

Efforts by Arab countries to enhance agricultural development, particularly for food security, has led to the establishment of the Arab Authority for Agricultural Investment and Development (AAAID) in 1976. AAAID accomplishes its mandate through investments in plant and animal production, food processing, manufacturing of agricultural equipment and inputs, and provision of related services.

Investments by AAAID in 32 existing companies reached a total of \$336.1 million distributed over 13 Arab countries, with Sudan capturing

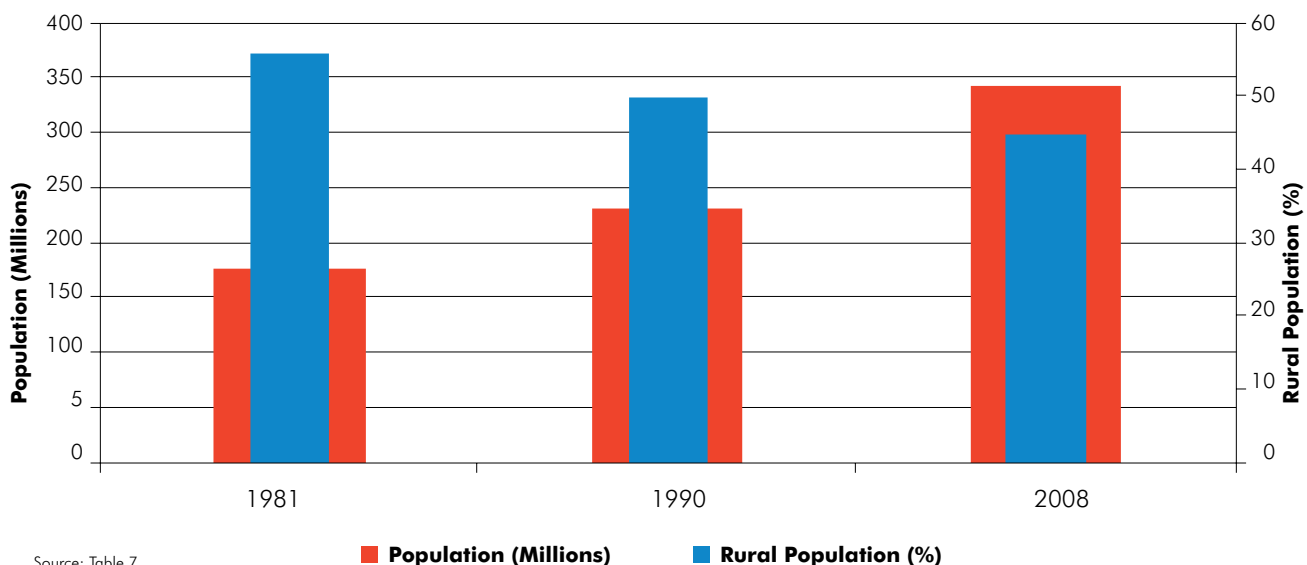
about 56% of all investments. The total amount invested by AAAID and its public and private sector partners amounted to \$2.45 billion by the end of 2008, with the public sector contributing a share of 56.3%, the private sector 30.1%, and AAAID 13.6% (AAAID, 2008).

These figures indicate that despite its concerted efforts over three decades of agricultural activities, AAAID's investments remain dominated by the public sector and overshadowed by investments in one country (Sudan). Furthermore, the average annual investment at about \$80 million per year is considered low, with the private sector contributing only \$25 million.

It is not surprising that AAAID could not attract more funds for its investments, given the bias against agriculture, in general, stemming from the perception that agriculture is an area fraught with risk and low return. The Arab Investment and Export Credit Guarantee Corporation (AIECGC) estimated inter-Arab direct investments at about \$35.9 billion and \$19.2 billion in 2008 and 2009, respectively. Four countries (Jordan, Libya, Tunisia, and Yemen) attracted investments from other Arab countries amounting to about \$1.6 billion in 2009, with the bulk of this amount channeled for the industrial and services sectors, and only a mere share of 0.23% for agriculture (AIECGC, 2008).

FIGURE 2

## POPULATION AND RURAL POPULATION IN ARAB COUNTRIES



Source: Table 7

Support for investments in agriculture in Arab countries has not been confined to inter-Arab direct investments or to ODA from international donors and development organizations. Members of the Arab Coordination Group consisting of Arab national and regional development institutions, which include Abu Dhabi Fund for Development, Kuwait Fund for Arab Economic Development, Saudi Fund for Development, Arab Bank for Economic Development in Africa, Arab Fund for Economic and Social Development, Arab Monetary Fund, Islamic Development Bank, and the Organization of Petroleum Exporting Countries (OPEC) Fund for International Development (OFID), have been a main source of agricultural investments in the region. These institutions have supported numerous food production and infrastructure projects in Arab and other developing countries. Their financial contributions to food security, development of water resources, and construction of dams are estimated to be \$6.7 billion, or about 12% of their total operations as of the end 2008 (GSLAS et al., 2009).

Despite efforts made so far to develop the agricultural sector in Arab countries, particularly as a source of food security, there are still various impediments to achieving the desired outcomes. As summarized in the Unified Arab Economic Report, the barriers include the lack of a suitable investment climate including necessary laws, legislation, and incentives, inadequate infrastructure, and the lack of preferential treatment for agricultural projects. Movement of the factors of production capable of establishing an Arab regional market conducive to attracting agricultural investments is unnecessarily limited. In addition, having similar agricultural production patterns limits utilization of each country's comparative advantage and weakens Arab countries' competitiveness in external markets (GSLAS et al., 2009).

The Arab Economic, Development and Social Summit held in Kuwait in January 2009, adopted a resolution for an Emergency Program for Arab Food Security to be implemented over the period 2010-2030, with an estimated cost of about \$65 billion to be funded by equal shares from the public and private sectors. This

is an ambitious program in terms of its cost and objectives. The success of the resolution hinges, among other things, on laying down the groundwork for implementing economically and financially viable projects.

#### **vi. Livestock husbandry and rangelands**

According to the Arab Center for the Study of Arid Zones and Dry Lands (ACSAD, 2007), Arab countries have significant livestock resources in terms of headcount and species. Farm animal resources include 38 breeds of sheep, 54 breeds of goat, and 38 breeds of camel, with the majority of breeds adapted to dry environmental conditions. In addition, there are 22 breeds of cattle, 9 breeds of horses, and 3 breeds of buffalo. Despite rich farm animal genetic resources in Arab countries, their productivity of meat and milk is considered sub-average or low, as indicated in Figure 1, due to the lack of significant genetic improvement programs, poor production systems, and the mismanagement of natural resources particularly water and rangelands. The low productivity in animal products has caused many socio-economic challenges for the local communities, including lower income than what can potentially be attained (ACSAD, 2007).

Most rangelands in the Arab region are distributed in the semi-arid and arid areas with a variable and non-uniform rainfall distribution. The alternation of moist and long dry periods in this area predetermines the productivity and carrying capacity of rangelands. Poor soil fertility aggravates the impact of socio-economic factors which are the result of poverty, market conditions, land tenure (inheritance, land fragmentation), the absence of policy, and weak implementation of legislation regulating rangeland management (Darwish and Faour, 2008).

In the event of a multi-year drought, rangelands and livestock deteriorate and crops fail. Rangeland degradation takes multiple forms: the loss of plant cover and in turn the capacity to provide feed for the livestock, as well as the invasion of species (Kassas, 2008). Rangeland degradation is caused by overgrazing, i.e., exploiting the range beyond its carrying capacity (Kassas, 2008). Recurrent droughts and the absence of any conservation measures compound the problems associated with overgrazing.



TABLE 8 THE POOR\* ARE CONCENTRATED IN RURAL AREAS (2008)\*\*

| Country               | Percent of urban who are poor (%) | Percent of rural who are poor (%) | Percent of poor in rural areas (%) |
|-----------------------|-----------------------------------|-----------------------------------|------------------------------------|
| Algeria***            | 10                                | 15                                | 52                                 |
| Djibouti***           | 39                                | 83                                | 31                                 |
| Egypt***              | 10                                | 27                                | 78                                 |
| Jordan***             | 12                                | 19                                | 29                                 |
| Mauritania****        | 30                                | 50                                | 78                                 |
| Morocco***            | 5                                 | 15                                | 68                                 |
| Sudan****             | 27                                | 85                                | 81                                 |
| Syria***              | 8                                 | 15                                | 62                                 |
| Tunisia***            | 2                                 | 8                                 | 75                                 |
| West Bank and Gaza*** | 21                                | 55                                | 67                                 |
| Yemen***              | 21                                | 40                                | 84                                 |

\* Poverty as determined by national poverty line

\*\* Data for Mauritania and Sudan are for 2007

Source: \*\*\* World Bank, 2008; \*\*\*\* IFAD and FAO, 2007

Though there is no statistical information about the actual decline in the contribution of rangelands to livestock production, changes in vegetation composition and the downward trend in monitored sites in the region are indicative measurements. A general trend is a decreasing contribution of rangelands to livestock feed and an increasing contribution of other types of feed such as wheat straw and stubble, standing barley and barley grain, and agro-industrial by-products (Mirreh, 2009). In Tunisia, the contribution of rangelands to livestock diet has decreased from 65% to 10% (Nefzaoui, 2002). In Jordan, rangeland ecosystems used to provide 70% of the feed requirements for animal grazing; today, the contribution of rangelands to feed has declined to 20-30% (Roussan, 2002).

Past attempts to introduce unrealistic technical packages developed in the stable environments of high potential areas were unsuccessful. Even the research programs conducted in dryland range sites did not offer applicable results, and most of the findings have remained 'on the shelves' unutilized. The complexity of rangeland improvement technologies, lack of full comprehension of socio-economic conditions, ecological unsuitability, lack of incentives to undertake time-consuming and expensive conservation and management

activities in publicly-utilized areas are but a few of the many reasons for poor adoption by livestock owners. In addition, research and technology transfer programs are not based on traditional and contemporary practices of the local populations. Therefore, future attempts for technology development and transfer should be demand-based and predicated on applied and adaptive research supervised and implemented by the stock-owners themselves (Sidahmed, 1996).

The traditional wisdom and knowledge of the nomads and extensive livestock herders is becoming the center of attention. Therefore, future research and technology transfer should be based on well-identified demand by the herders and should build on what was known from the past. New technologies should complement, support, or modify useful indigenous skills and practices.

Given the animals' seasonal feeding patterns, a mismatch between land carrying capacity and grazing pressure is observed indicating the necessity to develop alternative fodder resources to reduce pressure on rangelands. This could be achieved through the development of irrigated fodder crops where arable land could be secured for such purposes, and intermixed irrigated pasture-fruit

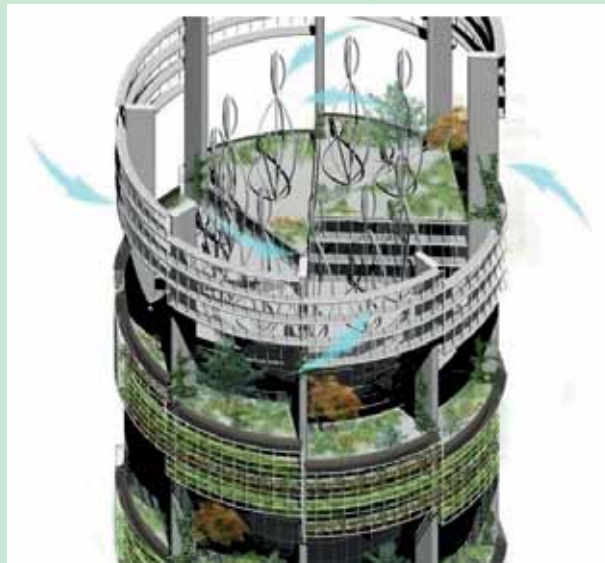
## ORGANIC FARMS IN OUR CITIES?

**Hala Chaoui**

In most countries, agricultural production happens out of sight out of mind, far from urban areas. Migration into cities is creating a disconnect between people and their food, and most farms do not meet the standards of the general public because they treat animals inhumanely and cause environmental side-effects. But what if we didn't have to choose between farms or cities — what if we lived in healthy environments that combined both, by growing food in edible urban gardens? These would filter the air, soften the visually polluted urban landscape, increase local food production, and save on food costs. It would also create a sink for urban food waste (if recycled as fertilizer) and reduce the carbon emissions caused by transporting food from remote farms.

Before moving into the city however, agriculture has to be free of environmental health hazards, space-efficient, and convenient. Conventional agricultural practices are unappealing to the urban work force, require large plots of lands, and can cause health issues to operators (carcinogenic pesticides). In addition, conventional synthetic inputs (fertilizers, pesticides) are fossil-fuel based and are not environmentally sustainable. Their use results, for example, in aquatic death-zones due to phosphorous and nitrate leaching into underground water.

Organic farming is an ecological alternative that would fit in cities and is a growing business sector at the fringes of North American cities. Time magazine published an article on the subject titled "Inner City Farms" (July 24th, 2008). Vertical farms powered by green energy optimize the use of urban resources, including land and organic waste, to grow plants. These are described by Dickson Despommier in the book *Vertical Farms* (2010) and shown in Figure B1. New technologies such as weeding robots are emerging to equip small organic farms. These reduce labor needed for weeding, which is the most strenuous part of organic farming. They include the Hortibot plant nursing prototype robot described by Jørgensen and co-authors\* in Denmark. A transplanting robot developed in Japan by Nagasaka and co-authors<sup>1</sup> also reduces farm labor and increases the crop's competitiveness against weeds. Robots can also repel pests mechanically, such as the bird-repelling Scarebot, developed by Hall and co-authors<sup>1</sup>, which repels fish-predating birds with water jets.



*Figure B1. Adapted from VerticalFarm.com by Despommier (Accessed July 2011). Photo credits: Architectural Design by Rolf Mohr; Modeling and Rendering by Machine Films; Interiors by James Nelms Digital Artist @ Storyboards Online.*

A small country like Lebanon could have more agility than large, established economies in terms of adopting new urban organic farming technologies. The country also has urgent reasons to green the cities and increase food security. In a country where new ideas catch on fast, high-tech urban organic farms could be among these ideas.

*Dr. Hala Chaoui is Principal, Urban Farms Organic Inc., Toronto, Canada. She designs small-scale equipment to conveniently turn food waste into organic fertilizer.*

\* Chaoui, H. I. and Sørensen, G. C. (2008). Review of Technological Advances and Technological Needs in Ecological Agriculture (Organic Farming). June 2008, Providence, Rhodes Island.

TABLE 9 AREA OF FOREST COVER AND DEFORESTATION RATE IN SOME ARAB COUNTRIES

| Country      | Forest Cover |                 | Primary Forest |                 | Loss      |                 | Gain      |                 | Tons of Carbon in Living Biomass (Millions) |
|--------------|--------------|-----------------|----------------|-----------------|-----------|-----------------|-----------|-----------------|---|
|              | Area (ha)    | % of Total Area | Area (ha)      | % of Total Area | Area (ha) | % of Total Area | Area (ha) | % of Total Area |   |
| Algeria      | 1,492,000    | 0.6             | 404,000        | 27.1            | 8,750     | 0.52            | N/A       | N/A             | 70  |
| Egypt        | 70,000       | 0.1             | 70,000         | 100.0           | 1,300     | 2.95            | 26,000    | 59.1            | 7   |
| Iraq         | 825,000      | 1.9             | 15,000         | 1.8             | 1,050     | 0.13            | 21,000    | 2.6             | 1   |
| Jordan       | 98,000       | 1.1             | 47,000         | 48.0            |           |                 |           |                 | 2   |
| Kuwait       | 6,000        | 0.3             | 6,000          | 100.0           | 150       | 5.00            | 3,000     | 100.0           | 1   |
| Lebanon      | 137,000      | 13.4            | 11,000         | 8.0             | 300       | 0.23            | 6,000     | 4.6             | 2   |
| Libya        | 217,000      | 0.1             | 217,000        | 100.0           |           |                 |           |                 | 6   |
| Morocco      | 5,131,000    | 11.5            | 621,000        | 12.1            | 4,100     | 0.08            | 82,000    | 1.6             | 223   |
| Oman         | 2,000        | 0               | 2,000          | 100.0           |           |                 |           |                 | 1   |
| Saudi Arabia | 977,000      | 0.5             |                |                 |           |                 |           |                 | 6   |
| Syria        | 491,000      | 2.7             | 294,000        | 59.9            | 5,950     | 1.60            | 119,000   | 32.0            | 1   |
| Sudan        | 69,949,000   | 29.4            | 6,068,000      | 8.7             | 321,600   | 0.42            |           |                 | 1393  |
| Tunisia      | 1,006,000    | 6.5             | 690,000        | 68.6            | 18,100    | 2.82            | 363,000   | 56.5            | 9   |
| U.A.E.       | 317,000      | 3.8             | 317,000        | 100.0           | 3,600     | 1.47            | 72,000    | 29.4            | 16  |
| Yemen        | 549,000      | 1.0             |                |                 |           |                 |           |                 | 5   |

Source: Data collected from rainforests section of Mongabay.com, 2010



TABLE 10 FOREST BIODIVERSITY IN SOME ARAB COUNTRIES

| Country      | Number of Species of Amphibians, Birds, Mammals, & Reptiles | Endemic Species (%) | Threatened Species (%) | Number of Vascular Plant Species |
|--------------|---|---------------------|------------------------|----------------------------------|
| Algeria      | 582   | 1.0                 | 4.5                    | 3164                             |
| Egypt        | 717   | 2.5                 | 4.0                    | 2076                             |
| Iraq         | 608   | 0.5                 | 4.9                    | n.a.                             |
| Jordan       | 571   | 0.7                 | 3.9                    | 2100                             |
| Kuwait       | 358   | 0.3                 | 3.9                    | 234                              |
| Lebanon      | 494   | 0.6                 | 3.2                    | 3000                             |
| Libya        | 486   | 1.2                 | 3.1                    | 1825                             |
| Morocco      | 675   | 4.3                 | 4.3                    | 3675                             |
| Oman         | 629   | 2.2                 | 4.8                    | 1204                             |
| Saudi Arabia | 636   | 1.4                 | 4.4                    | 2028                             |
| Syria        | 519   | 0.8                 | 3.3                    | 3000                             |
| Sudan        | 1431  | 1.6                 | 2.0                    | 3137                             |
| Tunisia      | 516   | 0.6                 | 4.3                    | 2196                             |
| UAE          | 339   | 0.0                 | 5.0                    | n.a.                             |
| Yemen        | 566   | 7.2                 | 4.1                    | 1650                             |

Source: UNEP-WCMC, 2010

n.a.: Not available

tree production for supplemental feeding during the dry months, especially in mountainous regions where irrigation water is available.

Rain-fed farmlands and rangelands could be 'integrated' in a mutually beneficial relationship between farmers and herders, whereby herders are allowed to use farmland stubble (after harvest), with livestock droppings improving the condition of the soil. Conflicts between the two groups arise when farmers expand their use onto rangelands, often in years with above average rainfall (Kassas, 2008).

## B. AGRICULTURE AND SOCIAL DEVELOPMENT

### i. Agriculture and Rural Development

Decline in the share of agriculture in Arab countries' GDP (Table 1) and that of agricultural labor in the total workforce (Tables 3 and 4) is associated with a similar drop in the percentage of population living in rural areas. Over the last three decades, the average percentage of people living in rural areas in Arab countries fell from

about 56% in 1981 to about 45% in 2008 (World Bank, 2010), as indicated in Table 7 and Figure 2.

Migration from rural to urban areas in Arab countries is a multi-dimensional phenomenon. Agriculture, primarily a rural activity, has not been able to cope with absorbing a commensurate share of the labor force growing at a rate faster than that in population growth. The figures in Table 4 demonstrate that the Arab population grew at a rate of 2.3% from 1990-1992 to 2005-2007, while the labor force increased by 3.6% annually, with the share of employment in agriculture declining at a rate of 2.3% annually over the same period. The lack of diversification in rural economies, coupled with weak links between agriculture and related industrial activities, such as small scale food processing and agro-industries, have impeded expansion of employment opportunities that would support livelihoods in rural areas.

Rural to urban migration in Arab countries has been exacerbated by inadequate infrastructure and social services. In considering the underlying motives for internal migration in some Arab countries,



Ben Jelili (2010) highlights the significance of the push and pull factors in the context of rural-urban migration. He points out that “one of the strongest factors in Egyptian internal migration is the search for better work opportunities than those existing at points of origin.” In the Moroccan case, he emphasized that “if rural poverty has been the main push factor, urban amenities such as education, health, and cultural services have been the main pull factors.” He further added that “in most Arab countries, the shift from a rural agrarian society to an urban industrial society involved widespread social and economic disruption, un-evenly distributed employment, and sometimes higher unemployment.” These social dislocations will be compounded by climate change disruptions, from more intense droughts to variable rainfall, jeopardizing agriculture and livelihoods in many rural areas. If agriculture is seen as a key sector for employment of rural labor and a main path out of poverty, rural-urban migration poses serious threats to efforts that address poverty reduction and unemployment.

### ***ii. Impact of agricultural policies on rural poverty and livelihood security***

If parts of the region have come to be known for opulence, millions of people in other Arab countries still suffer from multi-dimensional poverty. About one quarter of the population of Arab countries is poor, and 76% of the poor live in rural areas, as demonstrated in Table 8.

Households in extreme poverty may sacrifice productive inputs to purchase food, reducing their earning potential in the following years. Some poor households are undoubtedly forgoing spending on health and education in order to feed themselves, ultimately sacrificing the productivity of future generations. Household assets, such as land, physical capital, education, and health, are crucial factors in the ability of farmers to secure rural livelihoods and to participate and compete in agricultural markets (World Bank, 2008). Enhancing access to these assets is therefore critical to improving the purchasing power of farmers and will require significant public investment.

With three quarters of the poor living in rural areas, up to 40% of the population in the Arab Mediterranean region depends on agriculture, producing fruit, vegetables, and cereals. Decisions



on pace, sequencing, and scope of agricultural trade liberalization will undoubtedly have an impact on rural livelihoods in the region (Oxfam, 2004).

Investing in smallholder farmers is essential to eradicating rural poverty and increasing food security at the national level. Enabling smallholders to become more productive contributes to household food security, which contributes in turn to national food security. Therefore, securing the livelihood of smallholder farmers should be recognized as a food security goal (IFAD and FAO, 2007; FAO, 2008).

### **iii. Extension services and rural development**

The Arab region is known for its weak rural institutional structures and organizations (Yamouri, 2008). The agricultural sector in most Arab countries suffers from the lack of effective extension services. In addition, farmers need more responsive research and the capacity to utilize knowledge effectively. There is a great variation in production among farmers within a growing season, and from one season to another.

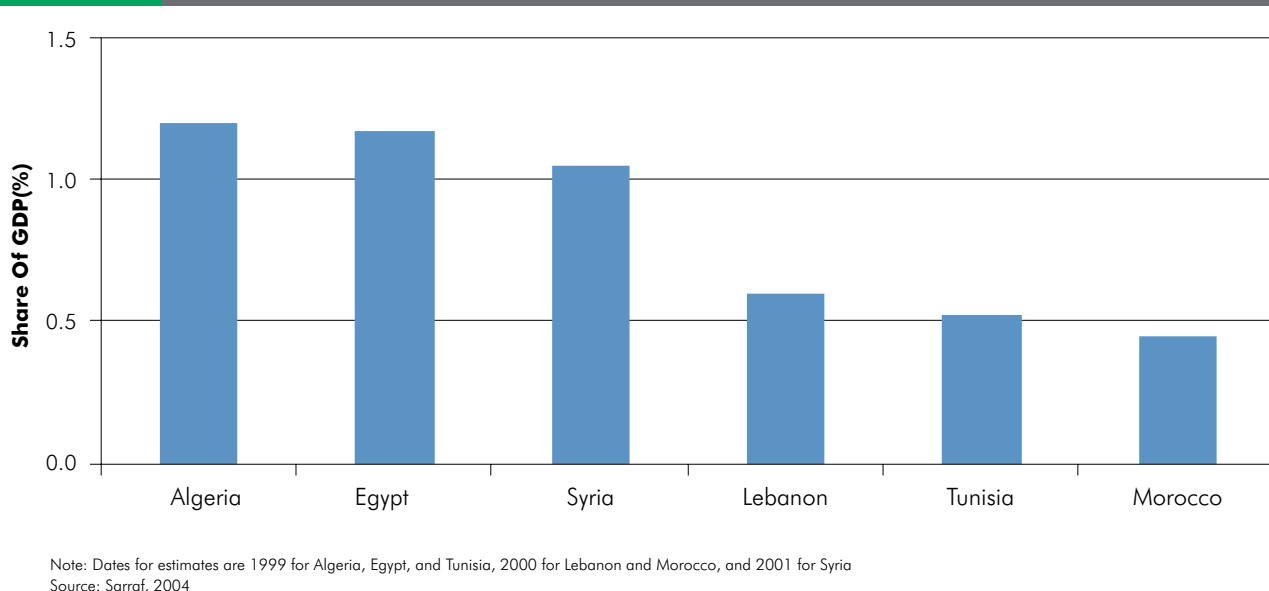
Irregular yields combined with the lack of regular marketing outlets for agricultural products deprives small farmers of a steady income stream. Smallholders may produce less food per hectare and per farmer than larger farms, but they make up a large proportion of the target population; extension's biggest failure has been not providing them with basic information (IAASTD, 2009). Though women participate actively in all farming operations, they do not benefit from extension services. Saito and Spurling (1992) indicated that, while some women may be trained as extension officers, very few of them venture out of their offices to interact with farmers.

### **iv. The impact of globalization**

Global forces are challenging the ability of developing countries to feed themselves (Altieri, 2009). A number of countries, including many in the Arab region, have organized their economies around a competitive export-oriented agricultural sector, based mainly on monocultures. This approach brings a variety of economic, environmental, and social problems, including negative impacts on public health,



FIGURE 3 ANNUAL DAMAGE COSTS FROM LAND DEGRADATION



ecosystem integrity, food quality, and in many cases disruption of traditional rural livelihoods, while accelerating indebtedness among thousands of farmers (Altieri, 2009).

### C. IMPLICATIONS OF AGRICULTURAL POLICIES ON ENVIRONMENTAL SUSTAINABILITY

#### i. Desertification

Desertification and land degradation are considered to be major environmental problems in Arab countries. The major causes of desertification are recognized to be the combined result of both human activities and natural environmental factors such as global climate change, drought, and soil erosion. Unsustainable human activities that are believed to contribute significantly to the degradation of land in the region include inefficient irrigation practices, overgrazing, uncontrolled agriculture, logging for fuel, and the mismanagement of water resources. Despite the lack of precise data for each source of land degradation, Sarraf (2004) developed order of magnitude estimates of the annual costs from land degradation to reveal the economic impact of degradation in six Arab countries, as indicated in Figure 3.

Agriculture and forestry are highly exposed to

climate change since they depend directly on climatic conditions. Forests regulate freshwater quality by slowing soil erosion and filtering pollutants. They also assist in regulating the timing and quantity of water discharge. From the range of goods and services provided by forest ecosystems, one of the most important for human development and wellbeing is preserving biodiversity and carbon storage. Forest vegetation and soil hold almost 40% of all carbon stored in terrestrial ecosystems. Forests in Arab countries are threatened by conversion to agricultural and other land uses, habitat fragmentation, and logging. Forest clearance and degradation are together a net source of carbon emissions. Expected growth in plantation areas will absorb carbon. However, at the current rate of deforestation, forests will remain a net source of carbon dioxide emissions and a contributor to global climate change (IUCN, 2008).

The condition of forest ecosystems from the standpoint of carbon storage is clearly declining, but with appropriate economic incentives, this trend could potentially be reversed. Table 9 below indicates the total area of forested area in some Arab countries, and the percentage of deforestation, as well as reforestation in each country and the total volume of carbon in the living biomass. The term primary forest refers to the most biodiversity and carbon-dense form of the forest.

TABLE 11 WATER AVAILABILITY AND USAGE IN ARAB COUNTRIES

| Country                     | Annual Availability                               |   |  | Annual Water Usage |                                 | % Use by Sector |          |             |
|-----------------------------|---|---|--|--------------------|---------------------------------|-----------------|----------|-------------|
|                             | Natural Renewable Resources Bm <sup>3</sup> /year | Desalinated End Water Bm <sup>3</sup> /year | Wastewater Reuse Bm <sup>3</sup> /year | Bm <sup>3</sup>    | As a % of Total Water Resources | Domestic        | Industry | Agriculture |
| <b>Algeria</b>              | 11.50   | 0.07  | Neg.                                   | 4.59               | 40                              | 25              | 15       | 60          |
| <b>Bahrain</b>              | 0.11  | 0.14  | Neg.                                   | 0.25               | 170                             | 26              | 3        | 71          |
| <b>Djibouti</b>             | 0.02  | 0.00  | Neg.                                   | 0.02               | 113                             | 88              | 0        | 12          |
| <b>Egypt</b>                | 61.90   | 00.06                                       | 5.90                                   | 73.10              | 108                             | 6               | 8        | 86          |
| <b>Iraq</b>                 | 80.00   | 0.03  | n.a.                                   | 42.80              | 48                              | 3               | 5        | 92          |
| <b>Jordan</b>               | 0.87  | 0.00  | 0.07                                   | 0.98               | 104                             | 26              | 7        | 68          |
| <b>Kuwait</b>               | 0.11  | 0.65  | 0.12                                   | 0.76               | 87                              | 37              | 2        | 60          |
| <b>Lebanon</b>              | 3.20  | 0.00  | n.a.                                   | 1.29               | 40                              | 28              | 4        | 68          |
| <b>Libya</b>                | 0.80  | 0.03  | n.a.                                   | 3.89               | 469                             | 9               | 4        | 87          |
| <b>Morocco</b>              | 20.00   | 0.02  | 0.07                                   | 16.84              | 84                              | 5               | -        | 95          |
| <b>Oman</b>                 | 1.60  | 0.12  | 0.02                                   | 1.22               | 74                              | 9               | 1        | 93          |
| <b>Qatar</b>                | 0.05  | 0.12  | n.a.                                   | 0.28               | n.a.                            | 23              | 3        | 74          |
| <b>Saudi Arabia</b>         | 2.50  | 2.28  | 0.15                                   | 17.00              | 506                             | 9               | 1        | 90          |
| <b>Sudan</b>                | 24.00   | 0.00  | 0.00                                   | 19.00              | 5                               | 6               | 5        | 89          |
| <b>Syria</b>                | 18.70   | 0.00  | 0.26                                   | 14.70              | 78                              | 9               | 1        | 87          |
| <b>Tunisia</b>              | 3.35  | n.a.  | 0.14                                   | 2.53               | 72                              | 12              | 4        | 84          |
| <b>UAE</b>                  | 0.20  | 0.95  | 0.14                                   | 1.60               | 180                             | 24              | 10       | 67          |
| <b>West Bank &amp; Gaza</b> | 0.76  | 0.00  | 0.01                                   | 0.44               | 57                              | 51              | 49       | 58          |
| <b>Yemen</b>                | 2.50  | 0.02  | 0.03                                   | 3.20               | 126                             | 5               | 2        | 93          |

Source: Barghouti, 2010

n.a.: Not available

Neg.: Negligible amount of water

Biodiversity loss reduces the productivity of ecosystems and undermines their resiliency in the face of natural disasters or human-caused stresses, such as desertification, thereby shrinking the basis for sustainable livelihoods. Not only are forest areas shrinking, but the capacity of remaining forests to maintain biodiversity appears to be significantly diminished. Forest cover enriches biodiversity by fostering different amphibians, birds, mammals, and reptiles. Table 10 below displays some statistics on the effect of forest cover on biodiversity in some Arab countries.

## ii. Water

Driven by population growth, industrialization, and improved standards of living, demand for

water in Arab countries is projected to increase significantly over the next decades. Dwindling natural water resources, estimated at about 313 billion m<sup>3</sup> in the Arab region (FAO, 2003), further limit expansion in agriculture. Of the 536 million hectares (FAO, 2005a) of agricultural land in Arab countries, the cultivable area does not exceed 197 million hectares, of which about 72 million hectares, including fallow areas, are currently under cultivation (GSLAS et al., 2009).

At the national level, annual per capita freshwater share has dropped in 13 Arab countries below the critical level of 500 m<sup>3</sup> per year, compared with a per capita world average of over 8,000 m<sup>3</sup> in 2007 (WRI, 2010). Under a business-as-usual scenario, the critically low water availability per capita will

be worsened by the effects of climate change. Table 11 summarizes annual water availability and usage in Arab countries. With 85% of available renewable water resources consumed by the agricultural sector, as indicated in the Table, the potential for increasing irrigated agriculture in Arab countries is limited. With limited and increasing scarcity of existing water resources, the remaining irrigation potential stands at about 7.3 million hectares (IFPRI, 2010).

As indicated in Table 11, the agricultural sector is a primary user of available water resources in the Arab region. Its share exceeds 75% of total available water, rising to 85% of available renewable resources. Some 60% of the region's water flows across international borders, further complicating the resource management challenge and posing serious uncertainties for agricultural output.

The scarcity of water resources has many consequences. It poses a challenge to food security and social stability of a growing population in the Arab region. It leads to further stress and degradation to ecosystems. It also causes long-term damage to soils and aquifers

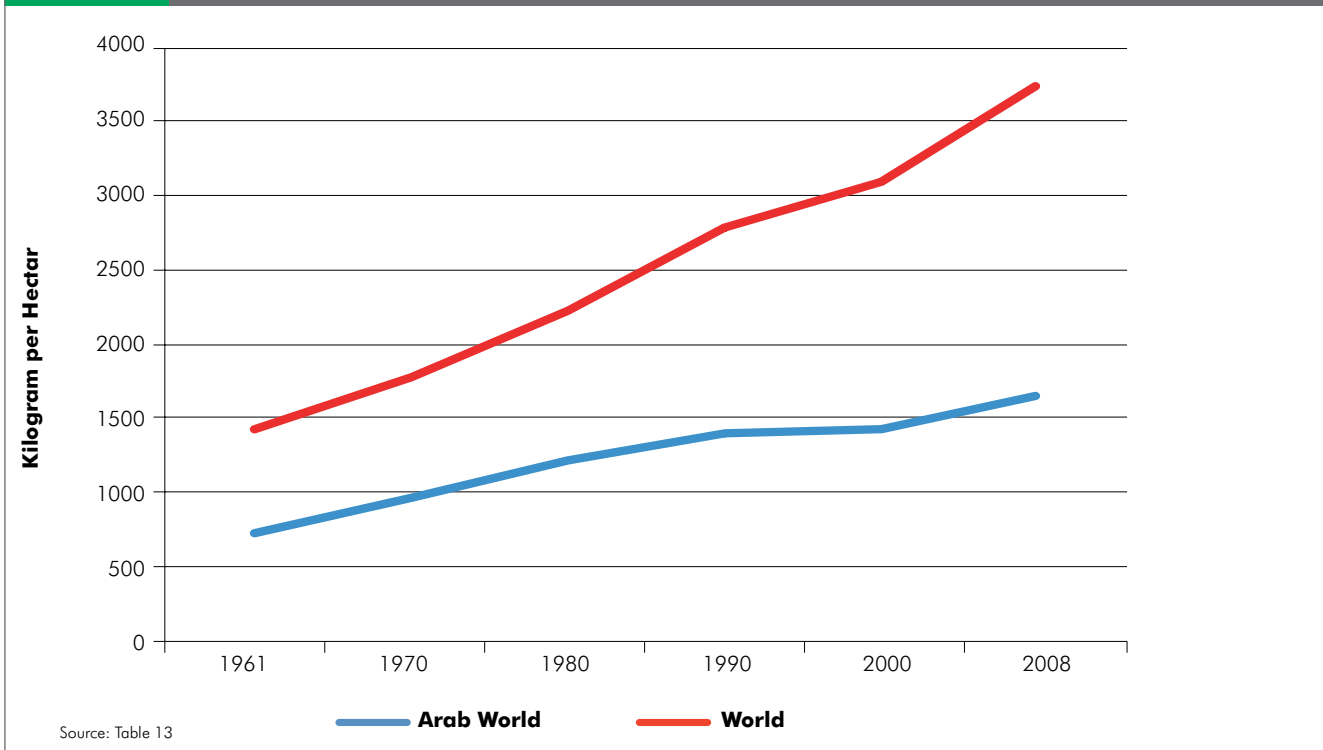
that may not be easily recoverable. The over-extraction of groundwater beyond safe yield levels has resulted in the pollution of existing groundwater aquifers.

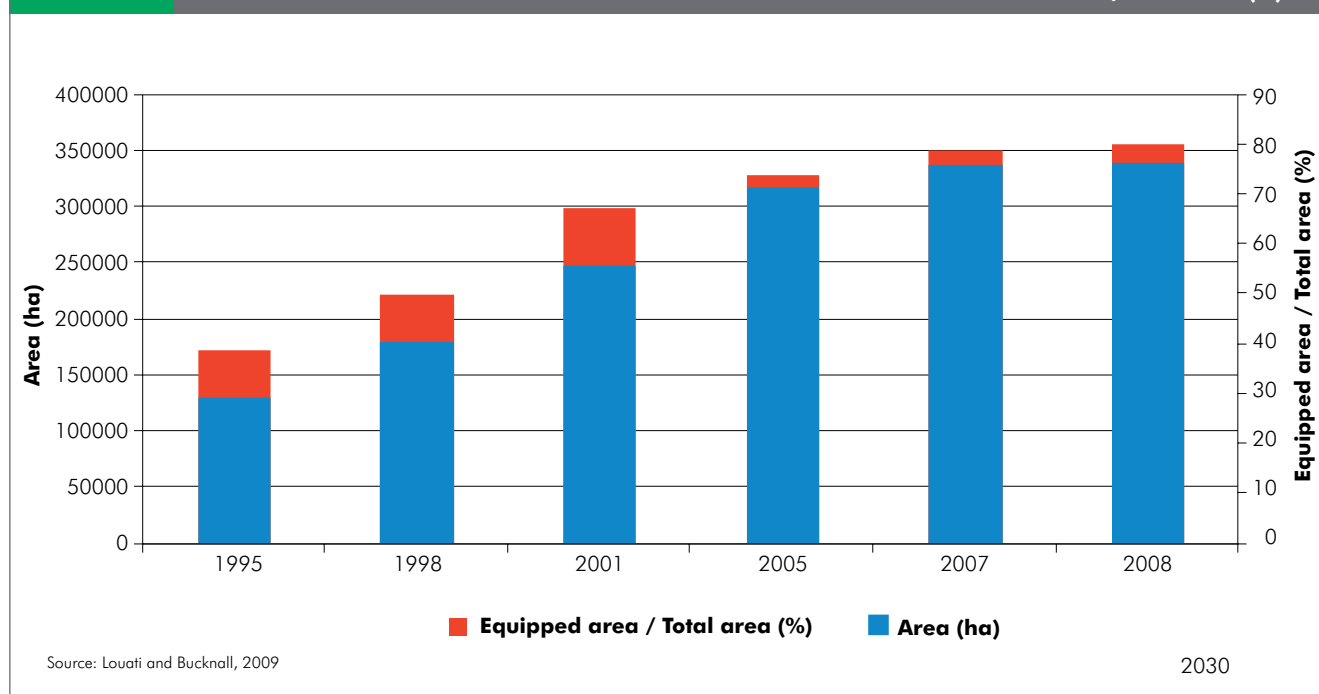
Arab countries have made water available at a low cost to farmers through public financing (Malik, 2008). Irrigation water prices in most Arab countries cover only a modest percentage of operation and maintenance costs. Water users often pay little for irrigation water publicly supplied to them, and incentives to change their growing patterns of water-intensive crops or to conserve water are absent (Barghouti, 2010). This policy has resulted in highly subsidized irrigated agriculture (Abu-Zeid, 2001), where low water prices have contributed to the extension of irrigated areas, increases in agricultural water demand, and the misallocation of the resource among users and uses. Low-cost recovery and poor maintenance have caused infrastructure deterioration, and poor water distribution efficiency, and irrigation performance (Malik, 2008).

Increased competition among sectors using water is affecting the quality and quantity of water being allocated to agriculture. Traditional irrigation

FIGURE 4

CEREAL YIELD: KILOGRAM PER HECTARE FOR SELECTED ARAB COUNTRIES



**FIGURE 5 TUNISIA IRRIGATED AREA EQUIPPED WITH EFFICIENT ON-FARM IRRIGATION SYSTEM, 1995-2008 (%)**


technologies (irrigation by gravity), which involve water delivery to plants through gravitation and have usually resulted in substantial water losses and limited uniformity in water distribution, have been replaced only in some areas by modern irrigation or pressurized irrigation (sprinkler and localized irrigation).

Water diverted and used for irrigation often causes environmental externalities and degrades natural resources (Malik, 2008). There are externalities due to over-extraction from, or contamination of, common-pool resources such as lakes and underground sources (Malik, 2008). From such a perspective, it is suggested that the costs of these externalities need to be considered while determining the cost of irrigation water.

In their case studies, Croitoru et al. (2010) considered the cost of salinity and water logging in Tunisia. They estimated the overall cost of water pollution and sedimentation that occurred in 2004 on irrigated agriculture in the country. Their conservative estimate of the total cost over 25 years ranged between US\$46 million and US\$62 million, with nearly 60% of these costs caused by salinity and water logging. The authors also estimated other costs attributed to water pollution including loss in fish production,

public health and tourism related costs, and biodiversity losses. The overall cost of water degradation and groundwater overexploitation in Tunisia was estimated to be on the order of US\$165.8 million, or 0.6% of GDP in 2004. The largest cost of environmental damage inflicted on the agricultural sector was caused mainly by the impact of salinity and water logging on irrigated agriculture. Over-extraction of groundwater caused the second largest economic loss due to costs incurred by pumping additional water and building new wells to make up for aquifer depletion (Croitoru et al., 2010).

High land productivity in certain locations can be achieved at the expense of sustainable use of renewable water resources, particularly ground water. Average water productivity in the Arab region is estimated to be US\$700/m<sup>3</sup>, which is only about 35% of the world average of US\$2000/m<sup>3</sup> (AOAD, 2008). All Arab countries use much greater quantities of irrigation water than is required. In 14 Arab countries the quantity of water required for irrigation was estimated to be 83 billion m<sup>3</sup>. Yet the actual quantity of water used was 198 billion m<sup>3</sup> in 2000, representing an irrigation efficiency of only about 40% (FAO, AQUASTAT). For countries that are completely dependent on irrigated agriculture and groundwater, such as countries of the Gulf



## VIRTUAL WATER

Virtual water is defined as the water embodied in a product, not in real sense, but in a virtual sense (Hoekstra et al., 2002). It has also been called 'embedded water' or 'exogenous water,' the latter referring to the fact that import of virtual water into a country means using water that is exogenous to the importing country. Thus, exogenous water is to be added to a country's 'indigenous water' (Haddadin, 2003). Hence, virtual water (net import of water in a water scarce nation) can relieve the pressure on a nation's own water resources. Virtual water can be seen as an alternative resource to water. Using this additional source can be an instrument to achieve regional water security.

Every year, farmers and traders in the Middle East move volumes of water equivalent to the flow of the Nile into Egypt, or about 25% of the region's total available freshwater. The water imported in this way is called "virtual water" (Allan, 1997).

Virtual water and water productivity combine agronomic and economic concepts, with emphasis on water as a key factor of production. The agronomic component addresses the amount of water used to produce crops, while the economic component involves the opportunity cost of water, which is its value in other uses that may include production of alternative crops or use in municipal, industrial, and/or recreational activities.

The virtual water perspective is consistent with the concept of integrated water management, in which many aspects of water supply and demand are considered when determining the optimal use of limited water resources (Bouwer, 2000). This concept might also reduce the financial burden of developing a new infrastructure for water distribution. In particular, the opportunity cost of water use, which is a key component of the virtual water perspective, must be considered when seeking an efficient allocation of scarce water resources.

As a scarce commodity, water should be treated economically and allocated efficiently according to its economic, social, and ecological value in alternative uses. The virtual water concept is economically appealing. It affords water-scarce countries a valuable solution to food security by importing water-intensive products at cheaper prices instead of using water to produce water-intensive products with low value.

However, the virtual water concept remains a debatable issue in the context of international trade in agricultural products, as is the case with the highly subsidized export products of the United States and the European Union, which render local prices of importing countries uncompetitive and counterproductive to the development of their agriculture. Furthermore, concern over timely and uninterrupted access to food due to shortage in supply or restrictions on exports constrains the adoption of the economic principles of the virtual water concept. It is a controversial issue, which emphasizes the complex links between water, agriculture, and politics (UNESCO, 2003a).

Under these circumstances, Arab countries need to optimize the use of virtual water and adopt flexible policies for employing virtual water for food security according to agricultural potential and comparative advantage. Such policies should be based on a thorough evaluation of alternatives for food security with a mix of practical options that lead to generating maximum economic, social, and environmental benefits. While virtual water can relieve pressure on scarce water resources in the region, cooperation between Arab countries according to comparative advantage in agricultural resources is essential for enhancing the security of food supply. Furthermore, ensuring the long-term security of food supply through the virtual water concept can be attained by cooperation between Arab countries with investable funds and other developing countries endowed with adequate land and water resources based on mutual benefits.

Cooperation Council (GCC), higher relative crop productivity is achieved by undermining the sustainability of their water aquifers, as a result of over-pumping.

According to Massarruto (2002), the social cost of water supply is not just the cost of the goods and

services that are required in order to make the water available for use, but also the costs that society has to bear in terms of reduced opportunities of using water resources in alternative ways and the costs that are necessary for maintaining and improving the quality and quantity of the water capital up to a level that is considered sufficient for long-term sustainability.

### iii. Effects on life support systems

Agriculture is a driver of environmental and climate change. Agricultural practices in Arab countries extract water from aquifers faster than they are being recharged. Through use and often misuse, toxic herbicides and insecticides are accumulating in ground and surface waters causing water pollution. These chemicals reduce biodiversity in the soil and pose health risks to agricultural workers who apply them in the fields. Chemical fertilizers run off the fields into water systems—lakes and rivers—causing changes in the biology of these aquatic systems that disrupt ecosystems and kill fish by depriving them of oxygen. In addition to land use changes that contribute significantly to greenhouse gas emissions, agriculture is an energy intensive activity, consuming large amounts of fossil fuels to produce, transport, and apply agrochemicals.

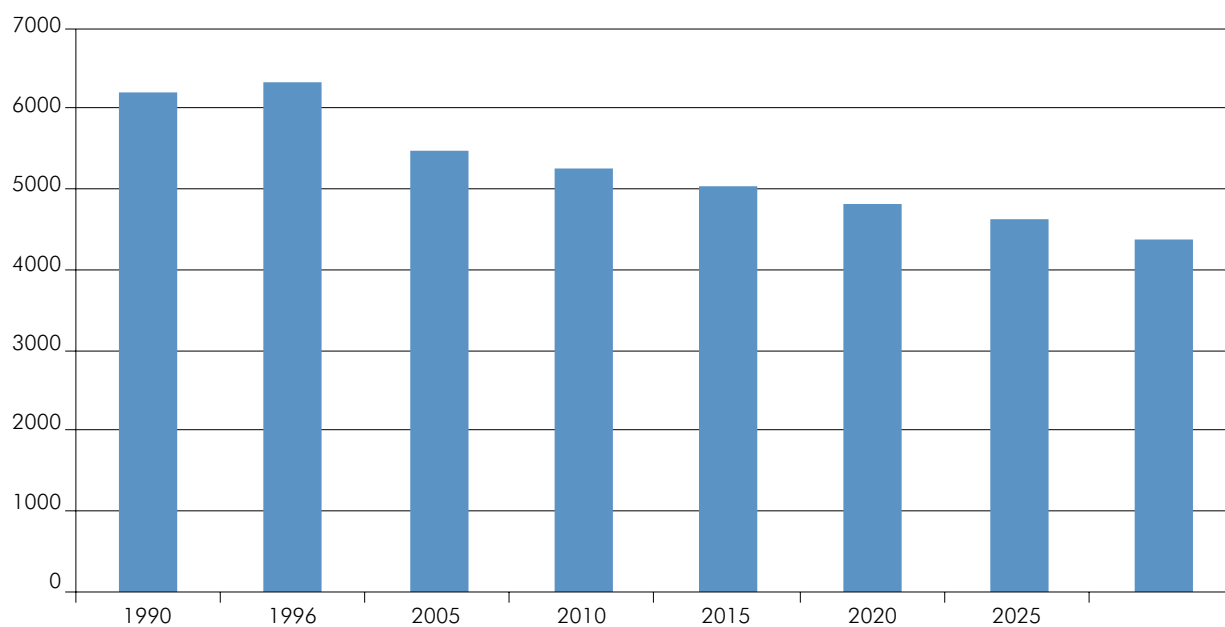
### III. FOOD SECURITY

Growth in world population, mounting pressures on limited land and water resources, and the environmental impact of the expansion and

intensification of agriculture raise high concerns about the prospects for future food security in the world. However, a study by the Food and Agriculture Organization (FAO) points out that “the historical evidence suggests that the growth of the productive potential of global agriculture has so far been more than sufficient to meet the growth of effective demand,” and “at global level sufficient production potential can be developed to meet the expected increase in effective demand in the course of the next five decades.” But it warns that “unless local agriculture is developed and/or other income earning opportunities open up, the food insecurity determined by limited local production potential will persist, even in the middle of potential plenty at world level. The need to develop local agriculture in such situations as the condition sine qua non for improved food security cannot be overemphasized” (FAO, 2006a).

According to the World Food Summit (1996), food security exists “when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life.” This definition implies that food

FIGURE 6

EVOLUTION OF MEAN WATER ALLOCATIONS PER IRRIGATED HECTARE, 1990-2030 (M<sup>3</sup>/HA)

Source: Louati and Bucknall, 2009

## IMPROVING THE PRODUCTIVITY AND STABILITY OF RAIN-FED CEREAL PRODUCTION

**Mahmoud Solh**

Dry areas, by definition, are characterized by lack of water. Renewable water resources are limited and rainfall is highly variable and unpredictable. This short-term climatic variability is likely to be exacerbated by longer-term climate change. Most climate change models predict that the dry areas of West Asia and North Africa will become much drier and hotter with changes in seasonal and spatial distribution of precipitation leading to an increasing incidence and magnitude of extreme weather events (droughts and floods). Countries with a high dependence on rain-fed agriculture will be at most risk as they are highly vulnerable to shifts in seasonal climatic pattern.

Crop production in the Arab world is limited by low, variable, and unpredictable yields. Production of staple food and feed crops, even in good years, is not adequate to satisfy demand. Domestic production of wheat, a major component of national diets, meets just over half the average annual consumption. Barley, grown principally in rain-fed marginal areas, is the principal livestock feed in the region. So, any improvement in the domestic production of cereal crops would contribute to import substitution and food security. With scarce renewable water resources, opportunities for expanding irrigation are limited and competing demands from urban and industrial uses are likely to limit the water already available for agricultural production. Under conditions of increasing water scarcity, the key to enhancing cereal production is in improving the productivity and reliability of rain-fed agriculture.

Average rain-fed cereal yields in the region are low. They also fluctuate considerably from year to year depending on rainfall, as indicated in Figure B1. The potential to increase rain-fed cereal productivity is demonstrated, first, by the yields achieved in experiments on research stations in the region, and second, by the yields achieved in other dryland countries, for example Australia, as Figures B2 and B3 indicate. The yield gap, the gap between yields on farmers' fields and those achieved on research stations, is due to a number of factors including environmental constraints, pests and diseases, and farmers' crop management practices.

The productivity and reliability of rain-fed cereal

production can be improved through an integrated approach that includes:

- a. Use of improved varieties that are adapted to both abiotic and biotic stresses.
- b. Using limited rainfall more efficiently and effectively by:
  - Improving on-farm soil, water, and crop management practices that conserve soil moisture and increase water use efficiency.
  - Using irrigation water conjunctively with rainfall through supplemental irrigation.
- c. Creating an enabling environment: identifying institutional and policy options that support the dissemination and adoption by farmers of productivity enhancing technologies.

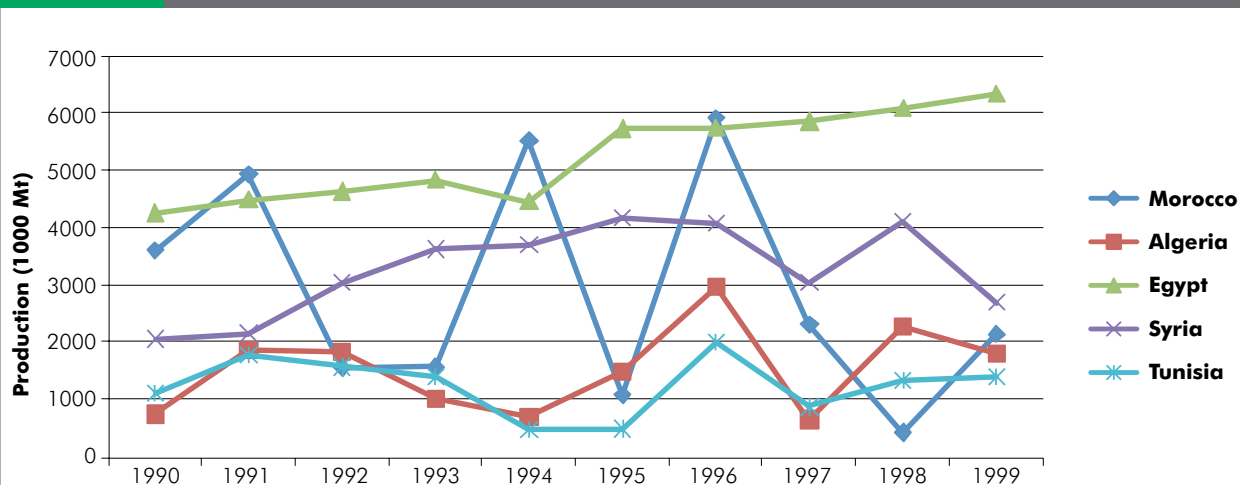
### 1. Improved germplasm and seed systems

Environmental stress factors, such as drought and heat, impose major limitations on crop productivity in dry areas and, with the growing evidence of climate change, dryland crop production systems are likely to be affected by increased and unpredictable drought and heat stresses. Improved germplasm with diverse drought and heat tolerant mechanisms, higher yield potential, resistance to diseases and pests, and with preferred traits for end-use requirements are needed. In addition, the improved varieties need to be targeted and disseminated to the production zones for which they were developed.

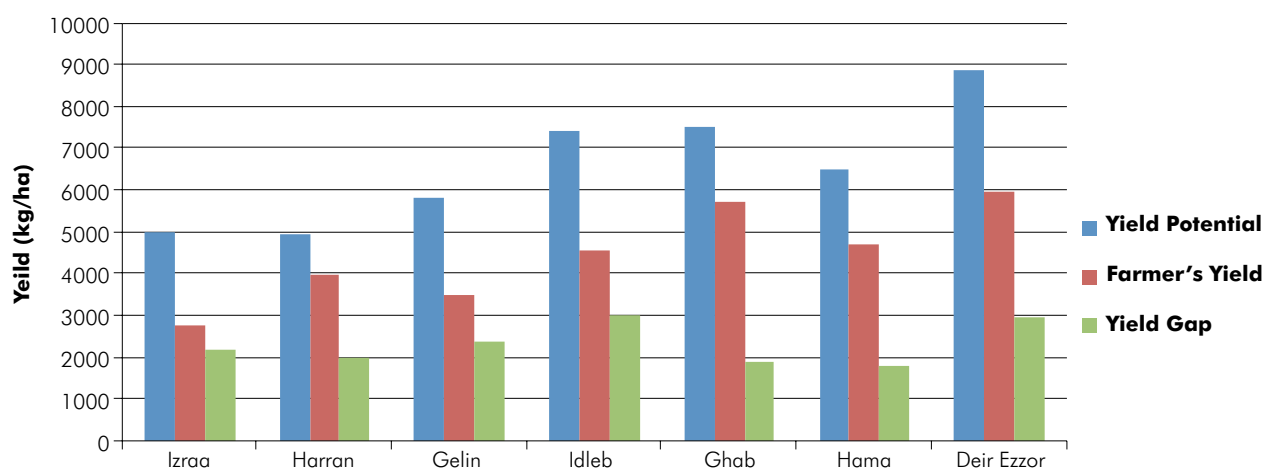
The benefits of improved varieties will only materialize if their seed is available to farmers. Seed security has become an increasingly important issue. Particularly in the less favorable and marginal environments, farming communities continue to rely on their own internal sources of seed. The capacity of both formal and informal seed systems needs to be strengthened in order to supply farming communities with quality seed of adapted varieties in a cost-effective and sustainable manner.

### 2. On-farm management practices

Improved varieties will only achieve their full potential if accompanied by integrated pest and disease management practices, based on environmentally sound interventions including bio-control, together with soil, water, and crop

**FIGURE B1 FLUCTUATIONS IN PRODUCTION (TON) FROM YEAR TO YEAR**


Source: ICARDA, 2007

**FIGURE B2 YIELD GAP IN SYRIA: THE DIFFERENCE BETWEEN FARMERS' YIELDS AND YIELD POTENTIAL AS DEMONSTRATED IN RESEARCH TRIALS**


Source: ICARDA, 2007

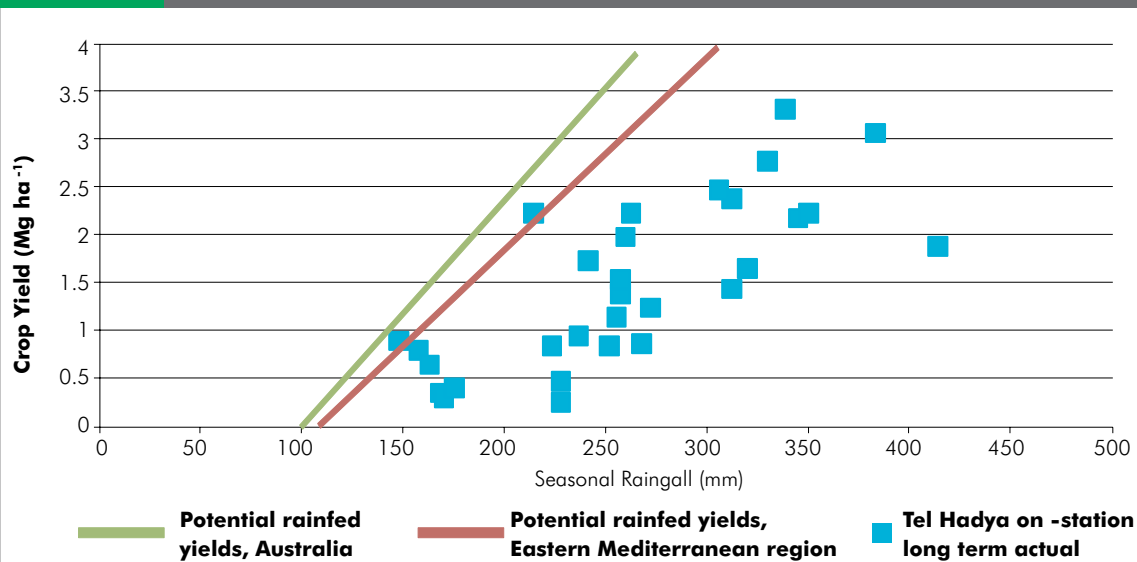
management practices. Good soil and crop management practices can considerably increase the efficiency of plant water use and productivity. These include use of recommended sowing date, seed and fertilizer rates, crop rotations, and disease and pest management practices. Maximizing the use of rainfall for crop growth can be achieved by good soil management that would reduce evaporation from the soil surface and improve infiltration and soil water holding capacity, thereby increasing the water uptake and transpiration by the crop.

The conjunctive use of rainfall and limited amounts of irrigation at critical periods to alleviate moisture stress substantially increases the yields of rain-fed crops. Trials at ICARDA show that adding supplemental irrigation of 70 mm, in a season with a rainfall of 320 mm, more than doubles yield. The use of supplementary irrigation is also a more efficient use of irrigation water. The productivity (yield per unit of water) of supplementary irrigation is substantially higher than it is in fully irrigated systems.



FIGURE B3

**LONG-TERM RAIN-FED WHEAT YIELD MODELING RESULTS (1980-2010): ACTUAL WHEAT YIELDS ON ICARDA'S PRINCIPAL RESEARCH STATION AT TEL HADYA, SYRIA, AND SIMULATED YIELDS FOR THE EASTERN MEDITERRANEAN REGION AND FOR AUSTRALIA**



Source: ICARDA, 2007

### 3. Institutional and Policy Support

Technology development by farmers requires institutional and policy support. Circumstances that may constrain or enhance the adoption of technologies need to be identified. This includes identifying the policy, institutional and social, environment under which rural

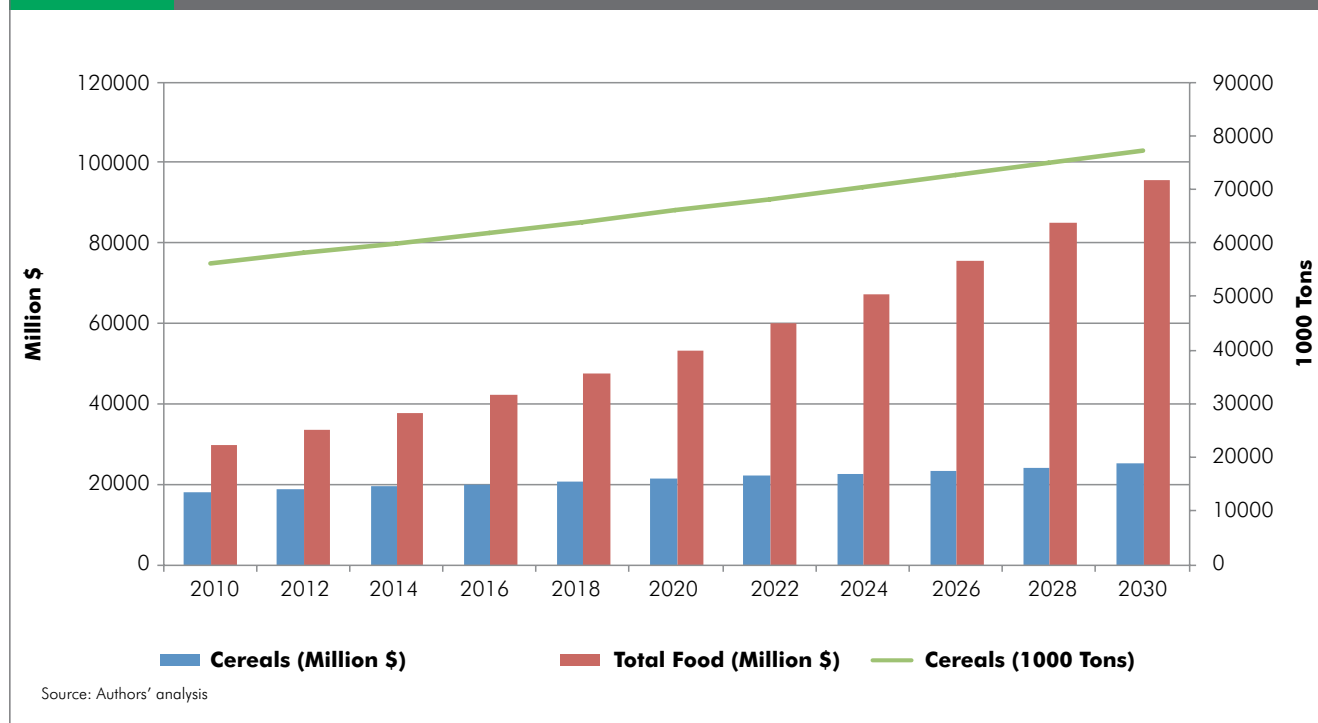
producers and communities make their decisions and the incentive and disincentive structures that shape their resource management, production and livelihood strategies.

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FIGURE 7

## PROJECTION OF FOOD IMPORT BILL: ARAB COUNTRIES (CONSTANT \$ 2008)



security rests on three main pillars consisting of availability of food, accessibility to it, and affordability for obtaining and using it.

Availability of food is a critical pillar in the structure of food security. It can either be made available from external or domestic sources, or a combination of both. Food security, regardless of the source of food, is a broader concept than self-sufficiency and local food production. Achieving food security through the broader or narrower approach depends on the agricultural resource endowments of a country, and its ability to manage them efficiently and sustainably.

Dramatic increases in world food prices in 2007-2008, caused by a number of factors, created a global food crisis with varying political, economic, and social implications on both developing and developed nations. Restrictions or outright ban by some countries on exports of main food commodities such as cereals undermined the concept of food security in the context of economic globalization and free trade. These developments renewed greater interest in the pursuit of food self-sufficiency by many developing countries, including Arab countries, with agricultural development reinstated at

the top of their agendas. The Arab Economic, Development, and Social Summit, which was convened in Kuwait on January 19-20, 2009, endorsed assigning a high priority for Arab regional food and water security, and approved action plans for their implementation.

In what follows we examine the agricultural potential in Arab countries for achieving self-sufficiency in main food commodities, focusing on cereals, which top Arab countries' food security programs. Arab countries are the largest net importers of cereals (World Bank et al., 2009), which constitute about 60% of food intake in the Arab region.

#### a. Food Gap

The food gap in Arab countries is widest in such commodities as cereals, sugar, and fats and oils. Statistics on self-sufficiency in major food commodities show that Arab countries achieved a self-sufficiency rate of about 45%, 32%, and 29% in cereals, fats and oils, and sugar, respectively, in 2008 (AOAD, 2009b). Closing the gap in cereals is much more important than that in fats and oils or sugar, because of cereals' relative fiscal impact on trade balances. The value of net cereals

## “SOUK EL TAYEB”: LEBANESE MARKET FOR ORGANIC FOOD

“Souk El Tayeb” is the first farmers’ open-air weekly market held every Saturday at Beirut Souks, Downtown Beirut, where fresh organic and traditional food is sold by producers from across Lebanon.

Farmers’ markets are first about creating a link between producers and consumers. Food is not anymore a commodity product on a supermarket shelf, but the labor of hands and traditional knowledge accumulated over generations by farmers. It is not just a loaf of bread, but the bread of Rima, the lettuce of Tony, the kebbeh of Suzanne. It is bringing back a major dimension to food: its human and cultural dimension. Food gets a face, and consumption becomes linked to production: farmers and producers receive recognition as well as a fair return on their labor. Food consumers get to build relationships with their farmers. The consumer, as an aware foodie, is offered food with an extra dimension of tradition (not any cheese, but darfyieh or serdeleh) and regionalism (not any olives, but those of Hasbaya or Aakkar). For many city inhabitants, the experience at the Souk re-establishes their relationship with the land as the source of their food. By linking the producer and the consumer, Souk El Tayeb helps shed away the nearly outcast position of the farmer, as a Fellah, reminding urban inhabitants of the appreciation and respect they owe the farmer.

A farmers’ market is no longer a conventional place to buy and sell, but a meeting place to bring the rural to the urban, to provide economic opportunities to small-scale farmers and producers, and to bring awareness about healthy eating and living. In short, it is a public space for interaction and learning about healthy nutrition and sustainable agricultural practices from organic farming to integrated pest management.

Created in 2004, Souk el Tayeb is a producers-only market, where producers sell directly to consumers without middlemen or intermediation. Souk el Tayeb is a one-day event: tents are set in the morning, and producers arrive with trucks holding their own production to sell for the day before they return to their farms. Souk El Tayeb events have been held weekly since 2004, without any interruption.

The number of participants has grown from 10 farmers in 2004 to about 60 farmers in 2011. The turnover ranges from \$300 to more than \$1000 a day per farmer. Producers offer four main categories of products at Souk El Tayeb: fresh fruit and vegetables, preserved food or “mouneh”, cooked food, and crafts (e.g., baskets, jewelry). One third of vendors at Souk El Tayeb are certified organic growers, with formal certification granted by organizations such as Istituto Mediterraneo Di Certificazione (IMC) or Liban Cert. Those farmers who are not certified practice traditional production methods, following strict rules and regulations that have been set up by the managers of Souk El Tayeb.

The demand for organic food has definitely increased since 2004. While sales figures are not available, Souk El Tayeb has experienced a steady rise in the number of organic produce growers—evidence of a growing customer base.

The success Souk El Tayeb has led to the expansion of the weekly market to include:

- One-day regional food festivals: Food & Feast are a series of festivals taking place in different Lebanese regions including Beirut, to promote local traditions and food specialties. The festivals are organized by Souk El Tayeb in partnership with local municipalities.

imports in Arab countries constituted over 61% of the total value (US\$29,863 million) of net imports of major food commodities in 2008, while fats and oils did not exceed 18%, and sugar only about 9% (AOAD, 2009a).

### **b. Cereal Production**

Cereals production in Arab countries varies widely and so is self-sufficiency, ranging between 0% in Djibouti to about 75% in Sudan, with an average of about 45.5% (2008) in the Arab region (AOAD, 2009a), as indicated in Table 12.

Three factors, namely, population, cultivable land, and water resources, play a key role in the future prospects for self-sufficiency in cereals in Arab countries. Arab population is projected to increase from 359 million in 2010 to about 493 million in 2030, and to about 600 million in 2050 (UN, 2010), with an implied growth rate of 1.6% over the period 2010-2030, and a rate of 1% over the period 2030-2050.

Per capita cereal consumption in Arab countries averaged about 309 kilograms annually over the period 2007-2009 (AOAD, 2009b).



- Dekenet Souk El Tayeb: A private label product line has been created containing a selection of the best items from a variety of small farmers and producers.
- Farmers' kitchen: Tawlet is where farmers and producers from the weekly market and from across Lebanon come to prepare traditional Lebanese dishes based on old family recipes. A salary is paid to each woman who cooks at Tawlet. Tawlet will buy any surplus food. The cooks and menus change daily, highlighting their specific village or region's cuisine.
- Souk@school includes a series of educational activities with schools and universities.
- El Tayeb Newsletter (and soon e-magazine) is published to inform, raise awareness, and discuss a variety of topics about green living, food, urban planning, eco-tourism, and green lifestyle.

Souk El Tayeb brings economic opportunities to small farmers by providing them with a stable stream of revenue. The fee for participating in the farmers' market has not changed since 2004. Farmers may also generate additional sources of income by participating in the Food & Feast festivals, Dekenet Souk El Tayeb, and farmers' Tawlet.

By way of expanding, Souk el Tayeb is working on building the Eco Souk, which would be a semi-permanent green space designed to serve as a farmers' market and meeting place. The Eco Souk will house a community garden, eco-playground for kids, communal kitchen, co-op shop, and a mini sorting and recycling plant. The space will adopt green architectural principles. The design calls for the reuse of locally recycled building materials and for power to be provided by renewable energy sources. This innovative concept seeks to bring Lebanese communities together in an eco-friendly green space, which is currently lacking but desperately needed in Beirut.



Notwithstanding the additional cereal production needed to tackle the existing malnutrition in certain Arab countries, and assuming a constant average of per capita consumption (309 kilograms annually), total cereal consumption is projected to reach about 152 million tons in 2030, and about 185 million tons in 2050. The Arab region would need to increase its current cereal production of about 52 million tons by about 100 million and 133 million tons in 2030 and 2050, respectively, to attain self-sufficiency. It is apparent that a significant increase in cereal production through expansion in irrigated land is

constrained by water scarcity. A more promising option can be found in using available water efficiently and productively.

### **c. Cereal Productivity**

Cereal productivity is a key factor in cereal availability for consumption in the Arab region. Unfortunately, it lagged behind compared to other regions of the world, and did not catch up with the technological advances that led to remarkable growth in cereal yields, especially in Latin American and Asian countries, by virtue of



## SAVE AND GROW

### A policymaker's guide to the sustainable intensification of smallholder crop production

This is the title of a new book published by the Food and Agriculture Organization (FAO), which calls for a new approach to produce more food for a growing world population in an environmentally sustainable way. It stresses that the present paradigm of intensive crop production is no longer capable of meeting the challenges of the new millennium.

The new approach builds on the lessons learned from the Green Revolution of the 1960s and its quantum leap in food production and bolstering food security in much of the developing world through decades of intensive farming based on high-yielding varieties, irrigation, agrochemicals, and modern management techniques. It is now recognized that the Green Revolution has not only lost its momentum as evidenced by the decline in the yield growth rate of major cereals, but it has also seriously jeopardized agriculture's natural resources base and its productive potential in the future.

FAO's new paradigm is based on "sustainable crop production intensification (SCPI), which produces more from the same area of land while conserving resources, reducing negative impacts on the environment and enhancing capital and the flow of ecosystem services". It calls for targeting mainly smallholder farmers in the developing world and helping them to save and grow through such practices, among others, as conservation agriculture, precision irrigation which derives more crop for the drop, and integrated pest management.

Highlights of an overview of the book chapters are quoted below as follows:

#### 1. The challenge

To feed a growing world population, we have no option but to intensify crop production. But farmers face unprecedented constraints. In order to grow, agriculture must learn to save.

#### 2. Farming systems

Crop production intensification will be built on farming systems that offer a range of productivity, socio-economic, and environmental benefits to producers and to society at large.



#### 3. Soil health

Agriculture must, literally, return to its roots by rediscovering the importance of healthy soil, drawing on natural sources of plant nutrition, and using mineral fertilizer wisely.

#### 4. Crops and varieties

Farmers will need a genetically diverse portfolio of improved crop varieties that are suited to a range of agro-ecosystems and farming practices, and resilient to climate change.

#### 5. Water management

Sustainable intensification requires smarter, precision technologies for irrigation and farming practices that use ecosystem approaches to conserve water.

#### 6. Plant protection

Pesticides kill pests, but also pests' natural enemies, and their overuse can harm farmers, consumers and the environment. The first line of defense is a healthy agro-ecosystem.

#### 7. Policies and institutions

To encourage smallholders to adopt sustainable crop production intensification, fundamental changes are needed in agricultural development policies and institutions.

Source: Adapted from FAO, 2011

the Green Revolution of the 1960s. The pattern of cereal yield in the Arab region and in the world over the period 1961-2008 is indicated in Table 13 and Figure 4.

Table 13 above indicates that average cereal yields depict wide variation by country, ranging from 567 kg per hectare in Sudan to 7,506 kg per hectare in Egypt in 2008. The strikingly low yield in Sudan and mediocre yields in other Arab countries, with the exception of Egypt and Saudi Arabia, compared with the world average, as indicated in Figure 4, can be partly explained by the quantity and quality of inputs such as irrigation water, seed varieties, fertilizers, and mechanization. Irrigation in the Arab region is applied to only about 27% of the total cultivated area, with an average fertilizer use of about 51 kg per hectare. In Saudi Arabia and Egypt, irrigation covers 95-100% of the total cultivated area, respectively, and fertilizer use is over 366 kg per hectare in the former, and about 99 kg per hectare in the latter (AOAD, 2008).

The relatively low cereal yields in most Arab countries could also be attributed, among other factors, to the degradation of rangeland, cropland, and forestland. In Morocco, degradation is believed to have been caused by the combined factors of the country's fragile soil, over-exploitation of rangeland resources by farmers, and the conversion of productive rangeland to marginal cropland under the pressure of population growth and increased demand for agricultural and livestock products (Sarraf and Jorio, 2010). Sarraf and Jorio had estimated the impact of land degradation on crop productivity in terms of losses in cereal yields, as most agricultural land is cultivated with cereals. For rangeland degradation, they estimated the total loss of forage production. The cost estimate of cropland and rangeland degradation in Morocco was US\$134 million in 2000, the equivalent of 0.4% of GDP. Cropland degradation accounted for 88% this cost. Since these cost estimates do not capture other effects, such as the impact of salinity on irrigated soil, the average cost estimates quoted here most likely underestimate the total cost of land degradation (Sarraf and Jorio, 2010).

#### d. Irrigation Efficiency

Irrigation efficiency is a relative term. It could be relatively low or high depending on whether it is estimated at the farm level or the water basin

level. It also depends on how much of the water lost replenishes underground aquifers, or on whether proper drainage systems were installed when irrigating with reused water. Nevertheless, improving irrigation efficiency requires appropriate policies which are no less important than modern irrigation systems and techniques in providing benefits by raising the level of irrigation water use efficiency (Sadik and Barghouti, 1997).

Paying little for irrigation water, water users have no incentives to change their pattern of growing water-intensive crops or to conserve water (Barghouti, 2010). Pricing irrigation water in accordance with its economic value not only improves cost recovery and reduces the burden on public budgets, but it also creates incentives for farmers to rationalize water consumption in irrigation. The application of appropriate cost recovery measures and the adoption of modern irrigation techniques can be instrumental in raising irrigation efficiency, which in turn leads to increasing water and crop productivity and reduces negative impacts on the environment.

According to Malik (2008), governments have been compelled to revisit their policies and engage in pricing reforms in order to improve cost recovery and, more recently, to shift to demand-management policies. Pricing experiences in Morocco and Tunisia are being oriented towards the objective of cost recovery, which contributed to the reduction of public financing of irrigation schemes in these two countries.

Louati and Bucknall (2009) refer to Tunisia's National Program of Irrigation Water Conservation (PNEEI) adopted in 1995 to improve irrigation efficiency to at least 75% by 2006 through the installation of efficient on-

TABLE 12 CEREAL PRODUCTION, NET IMPORTS AND CONSUMPTION (1,000 MT)

|                                  | 2001-2005 (Average) | 2008       |
|----------------------------------|---------------------|------------|
| <b>Production</b>                | 51,712.29           | 46,679.71  |
| <b>Net Imports</b>               | 46,998.78           | 58,770.44  |
| <b>Available for Consumption</b> | 98,711.07           | 105,450.15 |
| <b>Self Sufficiency (%)</b>      | 52.39               | 45.48      |

Source: AOAD, 2009a

TABLE 13 CEREAL YIELD: KILOGRAM PER HECTARE FOR SELECTED ARAB COUNTRIES

| Country/Region        | 1961  | 1970  | 1980  | 1990  | 2000  | 2008  |
|-----------------------|-------|-------|-------|-------|-------|-------|
| Egypt                 | 2,906 | 3,912 | 4,094 | 5,703 | 7,280 | 7,506 |
| Kuwait                |       | 2,000 | 3,188 | 3,653 | 2,324 | 2,690 |
| Lebanon               | 1,067 | 933   | 1,745 | 1,878 | 2,415 | 2,186 |
| Oman                  | 1,115 | 1,219 | 905   | 2,160 | 3,199 | 3,323 |
| Qatar                 |       |       | 2,623 | 2,897 | 4,099 | 3,560 |
| Saudi Arabia          | 1,319 | 1,277 | 588   | 4,245 | 3,516 | 5,049 |
| Sudan                 | 913   | 721   | 630   | 456   | 505   | 567   |
| <b>Arab countries</b> | 798   | 1,004 | 1,159 | 1,417 | 1,437 | 1,686 |
| <b>World</b>          | 1,430 | 1,829 | 2,307 | 2,882 | 3,065 | 3,707 |

Source: World Bank, 2011a

farm irrigation equipment. They point out that drip, sprinkler, and upgraded gravity irrigation were applied on 310,000 hectare, or 75% of the irrigated area, as Figure 5 indicates. Since the end of the 1980's, with the introduction of conservation measures and the provision of 40-60% subsidy for efficient on-farm irrigation equipment, water consumption per hectare started to decline sharply, dropping from 6,200 m<sup>3</sup>/ha in 1990 to about 5,500 m<sup>3</sup>/ha in 2005 and is projected to decline further, as demonstrated in Figure 6 (Louati and Bucknall, 2009). If allocated water per irrigated hectare reaches 4,100 m<sup>3</sup>/ha by 2030, about 840 million m<sup>3</sup> of water would be saved for an irrigated area of 400,000 hectare, which is sufficient to increase wheat production by about 840,000 tons, assuming an improved water productivity yielding 1 ton of wheat per 1000 m<sup>3</sup> of water.

In pursuing self-sufficiency in cereals, Arab countries are confronted with limited irrigation potential arising mainly from mounting water scarcity. Irrigation is essential, not only for increasing yields, but also for dampening fluctuations in production from year to year. Figure B1 depicts a relatively regular annual production of cereals over the period 1990-1999 in Egypt, where irrigation covers about 95% of the cultivated area, whereas in Morocco, where irrigation covers only about 16% of the cultivated area and drought is a recurrent phenomenon, wide fluctuations in cereal production have been observed over the same period (AOAD, 2008). Nevertheless, future prospects for increased

cereal production depend on improving cereal yield, raising irrigation efficiency and water productivity, and expanding cereal cultivation in rain-fed areas. Optimizing the use of virtual water (see Box: Virtual Water) and improving the productivity and stability of rain-fed agriculture will also contribute to increased cereal production (see Box: Improving the Productivity and Stability of Rain-Fed Cereal Production).

### e. Prospects for Self-Sufficiency in Cereals

In 2008, six countries (Algeria, Egypt, Iraq, Morocco, Sudan, and Syria) accounted for about 89% of all land under cereal production in all Arab countries and for about 88% of total cereal production. Increasing cereal production is largely limited by water scarcity. Therefore, improving irrigation efficiency is significantly important for boosting the potential of irrigation in raising cereal production.

Table 14 indicates projections for cereal demand and supply and for domestic and industrial water demand for the period 2010-2050 on the basis of a growth rate equal to the rate of population growth at 1.6% and 1.0% over the two periods 2010-2030, and 2030-2050, respectively. The projections also assume that irrigation efficiency is increased from its current level of 40% to 70%. Water savings, resulting from efficiency improvements, are accounted for by allocating them to cereal production.

TABLE 14 PROJECTION OF WATER AVAILABILITY FOR CEREAL PRODUCTION IN SELECTED ARAB COUNTRIES\*

| Water Uses (Million m <sup>3</sup> )  | 2008     | 2010     | 2030     | 2050     |
|---|----------|----------|----------|----------|
| <b>Domestic and Industrial</b>  | 31,518   | 32,595   | 46,372   | 57,372   |
| <b>Agricultural Uses: Irrigation (efficiency 40%)</b>                                     | 175,482  | 175,482  | 175,482  | 175,482  |
| <b>Total Water Uses</b>   | 207,000  | 208,077  | 221,854  | 232,854  |
| <b>Total Natural Water Resources</b>  | 254,880  | 254,880  | 254,880  | 254,880  |
| <b>Water Balance</b>  | 47,880   | 46,803   | 33,026   | 22,026   |
| <b>Cereal (1,000 tons)</b>  |          |          |          |          |
| <b>Cereal Demand</b>  | 74,000   | 76,000   | 101,000  | 119,000  |
| <b>Cereal Production (Current)</b>  | 46,000   | 46,000   | 46,000   | 46,000   |
| <b>Cereal Surplus (Deficit)</b>   | (28,000) | (30,000) | (55,000) | (73,000) |
| <b>Water Availability (Million m<sup>3</sup>)</b>   |          |          |          |          |
| <b>Water Saved (Irrigation efficiency 70%)</b>  | -        | -        | 52,645   | 52,645   |
| <b>Using Water Saved per Requirements for Cereal Production (1,500 m<sup>3</sup>/ton)</b> |          |          |          |          |
| <b>Cereal Production (1,000 tons)</b>   | -        | -        | 35,000   | 35,000   |
| <b>Cereal Surplus (Deficit) (1,000 tons)</b>  | -        | -        | (20,000) | (38,000) |

\* Algeria, Egypt, Iraq, Morocco, Sudan, and Syria

Source: Authors projections on the basis of data in AOAD, 2009a; World Bank, 2010; World Bank, 2011b; and FAO, AQUASTAT

Table 14 contains rough estimates of the impact of constrained water resources on cereal production in the selected countries. The calculations reveal first that improving irrigation efficiency to 70% would save about 53,000 million m<sup>3</sup> of water. The projections also show that allocating water savings to cereal production at a rate of 1,500 m<sup>3</sup>/ton would reduce the cereal gap to only 20 million tons and 38 million tons in 2030 and 2050, respectively. Reducing irrigation losses can contribute significantly to increasing cereal production, but improving cereal productivity offers even better prospects for reducing the cereal gap. Raising productivity from its low level of about 1,685 kg per hectare in the six countries to that of the world average of about 3,707 kg per hectare, coupled with an irrigation efficiency of about 70%, would increase cereal production by about 50 million tons, enough to generate a surplus of about 30 million tons and 12 million tons in 2030 and 2050, respectively. If Sudan alone were able to raise cereal productivity from its current level of about 567 kg per hectare to that of the world average, it would increase its production by about 28 million tons, enough to close the cereal gap of 20 million tons in 2030 (Table 14).

#### IV. GREENING THE AGRICULTURAL SECTOR

A new approach is needed for utilizing the limited land and the scarce water resources, built on best agricultural practices and enabling policies for developing economically viable and environmentally sustainable agriculture. Policy reforms should be designed with an integrated strategy comprising regulations and incentives and accompanied by targeted investments to provide the enabling environment for transformation. Along with institutional changes, Arab countries need to invest in rural infrastructure development, farmers' extension services, agricultural water productivity, research and development, and efficient irrigation.

##### A. Regulating irrigation water use

Water is an important input factor that should be regulated because most suitable and accessible fresh water sources in Arab countries have already been developed. The rising cost of new water resource development projects should steer Arab governments towards managing the available water resources more judiciously.

Arab countries should design policies that



TABLE 15 AGRICULTURE RESEARCH AND FUNDING IN NATIONAL AGRICULTURAL RESEARCH INSTITUTIONS

| Country           | Potential researcher years (PRYs) <sup>a</sup> | Funding (millions of 2000 US\$) | PRYs/100,000 rural residents | Funding as percent Ag-GDP |
|-------------------|--|---------------------------------|------------------------------|---------------------------|
| Algeria           | 575  | 14                              | 8                            | 0.4                       |
| Bahrain           | 32   | 3                               | 457                          | 17.9                      |
| Egypt             | 6,710  | 68                              | 27                           | 0.5                       |
| Iraq              | 770  | —                               | 30                           | —                         |
| Jordan            | 198  | 6                               | 35                           | 1.2                       |
| Lebanon           | 83   | 4                               | 66                           | 0.4                       |
| Libya             | 261  | 13                              | 83                           | 1.6                       |
| Morocco           | 606  | 40                              | 6                            | 0.9                       |
| Sudan             | 595  | 3                               | 3                            | 0.1                       |
| Syria             | 1,058  | 15                              | 22                           | 0.4                       |
| Tunisia           | 368  | 15                              | 16                           | 0.6                       |
| UAE               | 73   | —                               | 46                           | —                         |
| Yemen             | 245  | 6                               | 3                            | 0.8                       |
| <b>Arab world</b> | 11,574   | 187                             | 14                           | 0.5                       |
| <b>Brazil</b>     | 3,943  | 924                             | 11                           | 1.4                       |
| <b>Mexico</b>     | 3,097  | 357                             | 12                           | 1.6                       |
| <b>Argentina</b>  | 1,858  | 270                             | 45                           | 1.0                       |

<sup>a</sup> PRY: potential researcher year

Source: ICARDA et al., 1999 and IFPRI, 2008

promote efficient irrigation practices. A shift in policy focus from supply to demand management of water resources is universally considered to be the most cost-effective approach, particularly where water is scarce. Policies enforcing water demand management should be combined with water pricing to create the needed incentives for farmers to alter their irrigation practices and crop selection patterns. Appropriate water pricing can be critical in raising irrigation efficiency and increasing water productivity. In addition, improved cost recovery will result in better upkeep of agricultural infrastructure such as repairing leakage in water delivery systems. Irrigation efficiency can be promoted by providing incentives to farmers for the adoption of more efficient irrigation techniques such as sprinkler, drop, and localized irrigation. Such incentives may include access to credit for purchasing new equipment, among others.

Laws and regulations are also needed to control withdrawals from surface and underground aquifers

in order to maintain the sustainability of these water resources, ensure their efficient utilization, particularly in irrigation, and prevent the pollution of fresh water resources. In addition, more water would have to be allocated to ecosystems to enable their restoration and enhance their capacities to provide environmental services.

Raising crop productivity is key to making progress towards food security in the Arab region. Changing the focus from land to water requires not only new technologies and policies for water management but also a change in land use and cropping systems (Shobha, 2006). Conventional water management guidelines designed to maximize yield per unit area need to be revised for achieving maximum water productivity as opposed to land productivity (Shobha, 2006). Therefore, national policies need to be adjusted to encourage more efficient water use in agriculture and a new land use and cropping system that maximizes water productivity (Oweis and Hachum, 2003). Several research projects

TABLE 16 EXAMPLES OF CURRENT PLANT GENETIC ENGINEERING RESEARCH AT AGERI/EGYPT

| Discipline                        | Potato | Tomato | Cotton | Maize | Fava beans | Cucurbits | Wheat | Banana | Date palm |
|-----------------------------------|--------|--------|--------|-------|------------|-----------|-------|--------|-----------|
| Virus resistance                  |        | •      |        |       | •          | •         |       | •      |           |
| Insect resistance                 | •      | •      | •      | •     |            |           |       |        |           |
| Stress tolerance                  |        | •      | •      |       | •          |           | •     |        |           |
| Genome mapping and fingerprinting |        | •      |        | •     |            |           |       |        | •         |
| Fungal resistance                 |        | •      |        | •     | •          |           |       |        |           |

Source: Madkour, 1999

undertaken in the Arab region have demonstrated substantial increase in crop yield in response to the application of relatively small amounts of supplemental irrigation. Average rainwater productivity in Arab countries is about 0.35 kg/m<sup>3</sup>, although it may be increased to as high as 1.0 kg/m<sup>3</sup> with improved management and favorable rainfall distribution (Shobha, 2006). Efficient on-farm water use techniques, coupled with improved irrigation management options, better crop selection, improved genetic make-up, and timely socioeconomic interventions, can help to achieve this objective.

### B. Agricultural subsidy reforms

As part of a comprehensive strategy for rural, social, and economic development, Arab agricultural policies should reconsider the role of blanket subsidies. Whether they are politically or socially motivated, subsidies are poorly allocated investments that do not contribute to long-term livelihood security and always lead to over-consumption of agricultural inputs. What is required is an active policy to reverse years of neglect to the agricultural sector by investing in the agricultural economy, upgrading rural infrastructure, and providing social services in rural areas. A climate favorable to private investment and value addition in agribusiness and agro-industry needs to be created. To do so, governments should increase spending on rural infrastructure to facilitate access to markets and improve the delivery of services to agricultural businesses. Moreover, governments should provide incentives, assistance, and training to enable farmers to go beyond the production of raw commodities, and engage in value-added activities such as food processing. Such a strategy would lead to improved agricultural

practices, income diversification in rural areas, and decreased pressures on public government spending. It would also reduce rural-to-urban migration.

### C. Investment

The basic justification, in principle, for launching an Emergency Program for Arab Food Security is the growing net import bill for main food commodities, estimated to be \$30 billion, including about \$18.3 billion for cereals in 2008 (AOAD, 2009b). In constant 2008 prices and a growth rate of net imports equal to the projected growth in Arab population of about 1.6% per annum over the period 2010-2030, the net import bill for the main food commodities and cereals, will reach about \$96 billion and \$25 billion, respectively, in 2030, as demonstrated in Figure 7.

For cereals alone, the cumulative cost of net imports over the period 2010-2030 amounts to over \$450 billion. These indicative estimates point to the heavy burden on trade balances caused by the food gap. While much can be gained from achieving food self-sufficiency, this objective faces formidable challenges, and the extent of realizing it is closely linked to the actions, policies, procedures, and practices which will govern the exploitation of the available agricultural resources while maintaining their economic viability and environmental sustainability.

The long-standing neglect to agriculture and the complex factors contributing to this neglect, as highlighted earlier, cannot be tackled overnight. Serious efforts have yet to be made to establish an environment conducive to investment in agriculture, especially through private sector interventions.

The economic and financial viability of agricultural investments is of paramount importance for attracting funds from local and foreign public and private investors, as well as from donors and development institutions. It is hard to prescribe a size-fits-all approach to ensuring economic and financial viability of prospective agricultural investments, but gathered experience and lessons learned point to some common essential requirements necessary for better performance of agricultural projects.

Future investments in agriculture in Arab countries need to focus on boosting productivity — particularly water productivity — which forms the cornerstone of the economic and financial viability of any project, and should be coupled with all other investments in infrastructure and facilities needed to move the products from the farm to market without loss in their quantity or quality.

Recognizing that productivity cannot be overemphasized for enhancing the viability of agricultural investments, it will remain stagnant unless supported by research. “An overview of 289 studies on economic returns of agricultural research and extension, everywhere in the world, found medium rates of return of 58% on extension investments, 49% on research investments, and 36% in research and extension combined” (FAO, 2005b).

Comprehensive feasibility studies are an essential pre-requisite for designing and implementing agricultural investments. Very often such studies focus on computing economic and financial rates of return based on capital and operating costs without due consideration to the availability of suitable inputs such as seeds, fertilizers, and extension services. A development approach to agricultural investments is required. This would entail self-contained studies with terms of reference that span the whole spectrum of ingredients, activities, and structures related to agricultural production with a view to identifying bottlenecks and proposing solutions. Evaluating agricultural projects and drawing conclusions on their viability should be based on the multifunctional character of such projects, and their economic, social, and environmental dimensions.

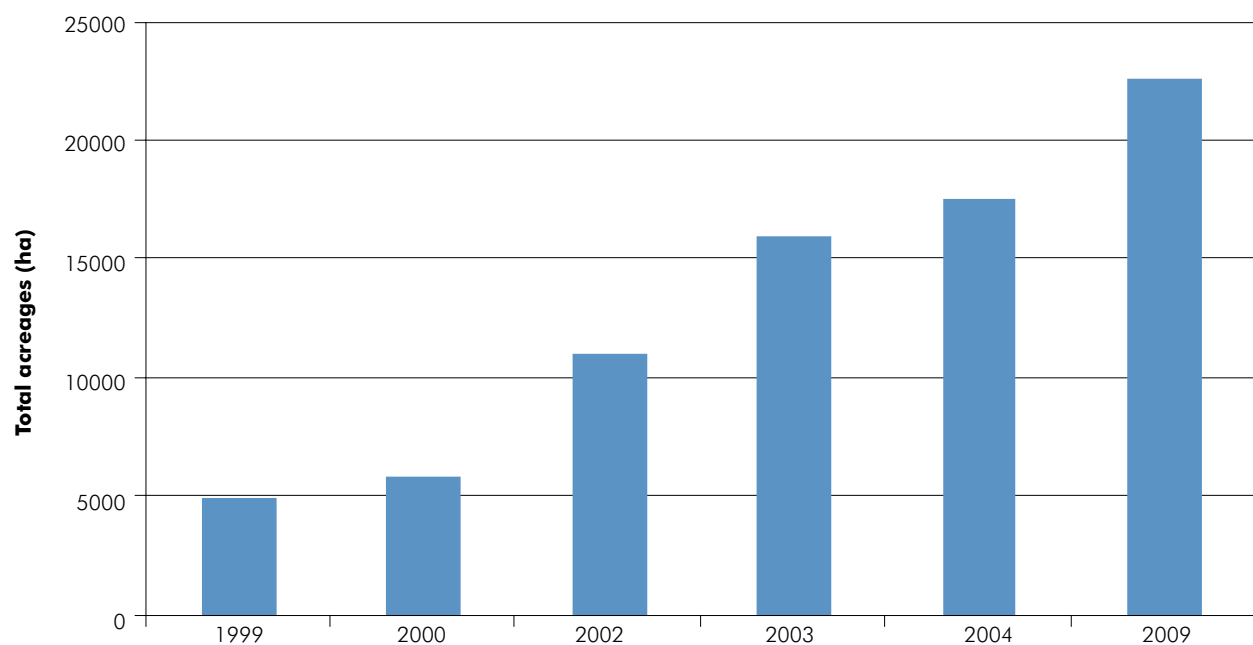
#### ***D. Knowledge based agricultural practices, training, and extension***

Governments must view farmers as equal partners in any strategy to transform the agricultural sector. This will require radical change in decades-long attitude about farmers not having decision-making powers and being at the receiving end of subsidies and set government prices. Farmers' associations and co-operatives must be strengthened in order to give farmers a strong voice in rural development and agricultural decisions. By establishing their own organizations, farmers will be better positioned to negotiate with agribusinesses and government regulators, cope with market changes, access information, and share knowledge about improved agricultural practices. Moreover, farmers' associations can contribute to improving the quality of interactions with scientists and experts and give legitimacy to farmers' traditional knowledge.

The complexity of agriculture demands that farmers have access to effective extension centers and training, reaching large and small farmers alike, to enable them to make the right decisions regarding seed selection and irrigation techniques. Therefore, it is critically important to train farmers and equip them with the necessary education, skills, and knowledge to build up their capacity to deal with ensuing issues such as new scientific applications or more sustainable farming techniques. For example, policies on crops to be grown based on their yield and economic return, as well as their water productivity (net revenue per unit water), adaptation to the climatic conditions, and impact on the environment should be addressed at the beginning of every growing season and made available to farmers.

Extension services should also provide up-to-date information to advise farmers on soil-water-plant relationship and proper irrigation scheduling as a function of crop growth stage and time. This concept is lacking among most farmers who rely on irrigated agriculture, despite their utilization of modern irrigation system technologies. Proper irrigation scheduling and deficit irrigation will improve irrigation efficiency and increase the quality and quantity of crop yield.

Knowledge-based agricultural practices, coupled with effective extension, will assist farmers with

**FIGURE 8 TOTAL ACREAGES OF ORGANIC FARMING IN EGYPT**


Source: Compiled from several sources

accessing markets for their products and enhance livelihoods in rural areas.

Furthermore, in the face of global trends, the concepts of food sovereignty and ecologically based production systems have gained much attention in the last two decades. New approaches and technologies involving the application of blended modern agro-ecological science and indigenous knowledge systems, spearheaded by thousands of farmers, non-governmental organizations (NGOs), and some government and academic institutions, have been shown to enhance food security while conserving natural resources, biodiversity, soil, and water in hundreds of rural communities in several regions (Pretty et al., 2003; Altieri, 2009).

Although the conventional wisdom is that small family farms are backward and unproductive, research shows that small farms are much more productive than large farms if total output is considered rather than yield from a single crop (Altieri, 2009). As the world's population continues to grow, redistributing farmland may become central to feeding the planet, especially when large-scale agriculture devotes itself to feeding cars through growing agro fuel feedstocks (Altieri, 2009).

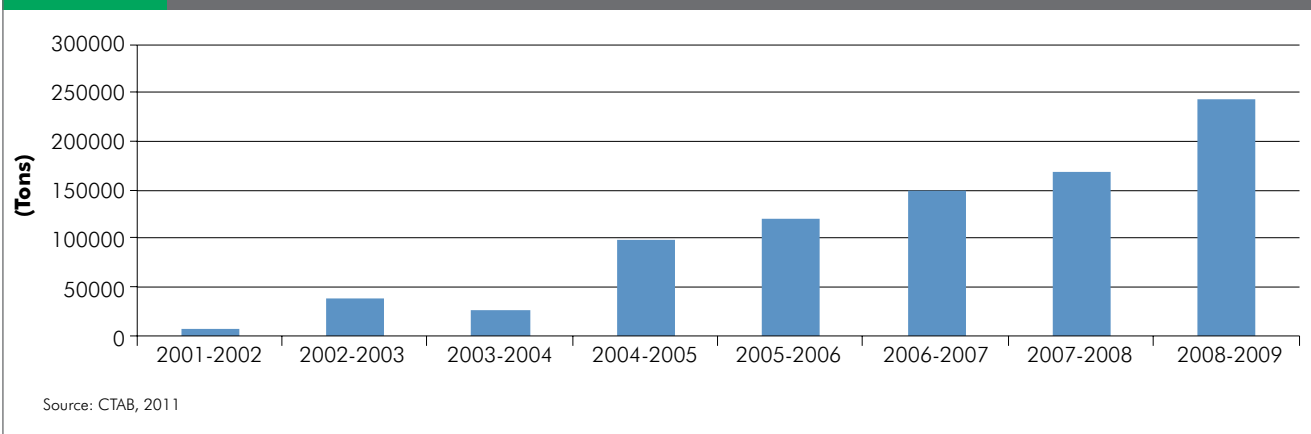
### ***E. Incentives for sustainable agricultural practices***

Current approaches to agriculture, aided by government-funded subsidies, involve intensive use, and often misuse, of chemical inputs that are known to contaminate soil, pollute rivers and aquifers, and cause damage to ecosystems. On the other hand, more sustainable forms of agriculture “treat the farm as an integrated system composed of soil, water, plants, animals, insects, and microscopic organisms whose interaction can be adjusted and enriched to maximize yields. This kind of agriculture is highly productive, takes advantage of natural systems and processes rather than ignoring or fighting against them, and is sustainable far into the future” (UCS, 2008).

Sustainable agricultural practices play a key role in maintaining soil fertility, conserving water, protecting ecosystems, and adapting to droughts or extreme weather conditions. These practices are grounded in traditional and modern science as well as in the economics of agriculture. To disseminate sustainable agricultural practices, effective extension services are needed to update farmers on emerging science. Targeted subsidies can help



FIGURE 9 TUNISIAN PRODUCTION OF ORGANIC PRODUCTS (TON)



farmers convert from intensive farming to more sustainable forms of agriculture.

### ***i. Investment in conservation and low input agriculture***

Conservation agriculture can help reduce food insecurity particularly in rural areas where agriculture is the main economic activity. This farming practice helps conserve soil moisture while improving soil fertility. It is a low input technology and it helps crops adapt to changing climatic conditions. Some of the benefits of conservation agriculture include: (i) minimal soil disturbance, (ii) use of mulch such as grass, leaves, crop residue, and manure, (iii) diversified crop rotations and intercropping to help improve soil structure and minimize pest outbreaks, and (iv) with timely land preparation and weeding, farmers can get good yields even in the event of a drought (Tsiko, 2011).

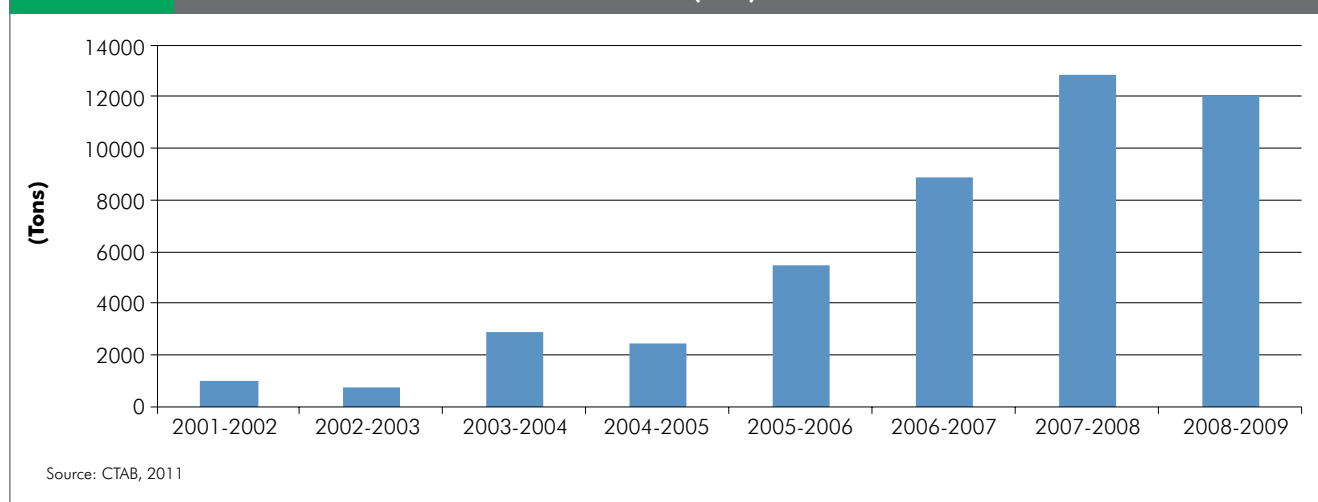
### ***ii. Deficit irrigation***

Deficit irrigation is defined as applying water to the plant at a fraction of the climatic demand or actual evapo-transpiration rate. Deficit irrigation is an optimization strategy under which crops are deliberately allowed to sustain some degree of water deficit and yield reduction. Deficit irrigation is a sustainable practice to cope with water scarcity. The optimization model objective is to maximize water productivity (revenue per unit water). Deficit irrigation is also an irrigation management tool. The user of deficit irrigation should have a very basic understanding of the soil-plant-water-climate relationship. Deficit

irrigation as a function of root depth of two crops, tomatoes and potatoes, was applied in Lebanon. The results for two seasons were encouraging (Nimah and Bashour, 2010). When deficit irrigation was applied using only 60% of the water requirement, the yield was not significantly different from that attained with full irrigation. If deficit irrigation is combined with plastic mulch, up to 60% of irrigated water can be saved without affecting yield. Plastic mulch is used to cover the soil with plastic sheets to control weed growth and prevent direct water losses through evaporation from the soil surface. Deficit irrigation will sustain irrigated agriculture, conserve water, and protect ecosystems. Therefore, Arab governments are urged to incorporate training in their extension services at the farm level to promote the adoption of deficit irrigation where possible.

### ***iii. Composting for reduced water and energy consumption and for improved soil fertility and productivity***

Arable land in most of the Arab countries is characterized generally by low organic matter content, which affects water retention as the amount of water used for irrigation is directly linked to the percentage of organic matter in the soil. Sustained plant growth requires slow release of water into the soil. High retention reduces the need to replenish water, and healthy plants in a moist bed rich in organic material need watering less frequently. Compost is not the only organic soil amendment available, but it is one of the least expensive and earth-friendly. Recycling vegetable waste and crop residues can help cut water bills.

**FIGURE 10 TUNISIAN EXPORTS OF ORGANIC PRODUCTS (TON)**


Soil organic matter is a key mechanism of holding water and nutrient. Any soil with structural problems, whether it is clay or sandy loam, will have improved water capture and retention with the application of compost. The addition of compost to loam soils with low soil organic matter can result in water savings of 20%. Water savings of 10% are readily achievable on a range of soil types. Typically, yield is directly related to the relative abundance of water. The addition of compost will enable storage of water near the root zone through the increased negative charge on humid surfaces. Substantial cost savings (both in reduced water usage and reduction in the use of commercial fertilizers) can be gained as a result of compost additions. Careful use of compost can significantly improve profits for a range of crops (Mangan Group, 2011).

A 22-year organic field study found that organic systems performed better in four out of five years of moderate drought by maintaining high levels of soil organic matter that helped conserve soil and water resources. Improving soil organic matter increases soil fertility while also increasing the water retention capacity of soils, thereby reducing the impacts of droughts, as well as reducing the risk of floods (Niggli et al., 2008; Altieri and Koohafkan, 2008; ITC, 2007). Sustainable farming practices such as mulching and integrating perennial crops and trees onto farms also conserve soil moisture and reduce the damage from extreme weather events.

#### **iv. Water harvesting**

Water harvesting has been a historically

common practice in many parts of the Arab world to cope with water scarcity. This practice may take on a new significance today because of the increased regularity of short duration, high intensity rainstorms believed to be induced by climate change. Water harvesting provides an opportunity to capture this voluminous runoff of rainwater.

Although, water harvesting at a household level and on the small farm level is of limited volume, it will partially supplement water requirements with good quality water. The harvested water can be mixed with less inferior water quality and can be used to supplement water demand for irrigation.

#### **F. Research and development**

Arab countries invest approximately \$1.4 billion annually in agricultural research and development (Pardey et al., 2006). This is about 1.3% of their combined agricultural GDP in 2008 (Table 1) and is higher than the developing country average of 0.53%, but far below the recommended investment level of 2% of agricultural GDP (IAASTD, 2009) and the level of investment by the developed countries. Arab countries increased spending on agricultural research and development (R&D) by only 0.05% of agricultural GDP from 1981 to 2000, whereas developed countries increased their spending by 0.95% (World Bank, 2008).

The number of agricultural researchers in Arab countries is relatively high, but they are under-

funded and under-equipped, as indicated in Table 15.

A potential researcher year is the equivalent of one year's worth of research. This unit is used because many researchers have a position that also consists of teaching, extension, and consulting, making them part-time researchers only.

For scholars with doctorate degrees, the financial incentives in a career in public sector research at national agricultural research institutes (NARIs) are generally inferior to the incentives in academia. Those who do join NARIs are often under equipped to be efficient in their research. Low investments in information technology and support staff are impediments to high quality research (IAASTD, 2009). Improving financial rewards and making resources available will attract competent researchers to agriculture and will drive the innovation needed to increase agricultural productivity.

#### ***i. Breeding for new seed varieties***

Plant breeding has played a decisive global role in the upsurge in yearly yields in agriculture, with 1-2% annual growth in recent decades. Progress in breeding has many facets and is consistently achieved for all crops, year after year (Bussche, 2009). The use of improved seeds, including disease resistant strains and other genetically engineered crops, certified as safe, needs to be widely adopted.

However, according to Ceccarelli (2003), yields of key crops are chronically low and crop failures are common in many parts of the Arab region. According to the same author, conventional

breeding programs aimed at improving crops have had little effect, largely because most farmers reject the adoption of the new varieties. Selection in well-managed experimental stations tends to produce cultivars that are superior to local landraces only under favorable conditions and improved management. These favorable conditions are not at the disposal of resource-poor farmers in Arab countries.

In the past, researchers have been able to depend on farmers to retain sufficient crop diversity and provide 'new' genetic material. But homogeneous modern agriculture threatens that source of genetic diversity, and thus threatens both local and global food security (Vernooy, 2003). The high-yielding varieties developed by the formal research system are often high-maintenance varieties. Many farmers reject plant breeders' offerings simply because they are not designed for marginal farmland; they meet neither the farmer's needs nor local preferences. Comparing the conventional and participatory plant breeding, Ceccarelli et al. (2001) mentioned that in the former, new varieties are released before knowing whether the farmers like them or not, while in the latter the delivery phase is reversed because the process is driven by the initial adoption by farmers at the end of a full cycle of selection. Rethinking conventional breeding strategies means recognizing the key roles of farmers and their knowledge and social organization in the management and maintenance of agro-biodiversity (Vernooy, 2003).

According to Kamal's (2008) survey and lessons learned, the main limitations and key challenges to plant breeding are the: (i) lack of financial resources to carry out field and laboratory experiments, (ii) need for an overall breeding strategy and priorities for future targeted crops

TABLE 17

CLASSIFICATION OF MEDITERRANEAN BIOCLIMATIC ZONES IN THE MIDDLE EAST BY PRECIPITATION

| Zone type          | Annual rainfall (mm) | Percent of arable area |
|--------------------|----------------------|------------------------|
| <b>Super-arid</b>  | < 200                | 0                      |
| <b>Semi-arid 1</b> | 200-400              | 74                     |
| <b>Semi-arid 2</b> | 400-600              | 14                     |
| <b>Sub-humid</b>   | 600-800              | 10                     |
| <b>Humid</b>       | 800-1200             | 1                      |
| <b>Super-Humid</b> | > 1200               | 1                      |

Source : Hazell et al., 2001

and activities in plant breeding, in light of recent advances of science and globalization of the world economy, (iii) inadequate number of senior scientists and lack of coordination among plant breeders and with scientists from other disciplines such as biotechnology for sustaining and improving breeding efficiency, (iv) lack of integrated data management information systems, and (vi) property right for protection of genetic resources and released varieties.

## **ii. Use of biotechnology for biotic and abiotic stresses**

Worldwide, private and publicly funded plant breeders are concentrating on a relatively small number of species. Biotechnology and genetic engineering appear, however, to reinforce this trend even further. Investments are concentrated worldwide on maize, rice, soya, and rapeseed. Other important species such as wheat, barley, and sunflower follow, but at a considerable distance. There are activities where the more important 'minor crops' are considered but to a much smaller extent (Schellnhuber et al., 2001).

Although more difficult to control and engineer than the usually monogenic traits of resistance to biotic pests and herbicides, the genetically complex response to abiotic stress is globally and regionally far more important. Therefore, breeding for plant tolerance to drought and salinity stress should be given a high research priority in all future agricultural biotech programs (Altman, 1999).

Among the opportunities for deploying modern biotechnological approaches in Arab countries, the following activities in Egypt can be enumerated: (i) producing transgenic plants resistant to indigenous biotic and abiotic stress, (ii) reducing

the use of agrochemicals and pesticides, and hence addressing their environmental risks, (iii) improving the nutritional quality of food crops, and (iv) reducing the dependency on imported agricultural products (seed-crops). Table 16 presents examples of current plant genetic engineering research at the Agricultural Genetic Engineering Research Institute in Egypt.

## **iii. Use of neglected species and rehabilitation of abandoned crops**

Efforts to re-establish neglected and underutilized species (NUS) can contribute to rural social development by improving the prospects of food security and income generation for small farmers (Will, 2008). The rehabilitation of NUS also offers significant potential to conserve agro-biodiversity and ecosystems. In addition to playing a role in a more balanced diet, some NUS can have medicinal applications. To take advantage of NUS according to Noun (2006), there is a need for: (i) detailed taxonomic studies to identify and classify plant species, (ii) investment in research on the potential use of local flora in medicinal applications and establishing realistic supply links to markets, (iii) promoting conservation of local and useful flora through cultivation and use, (iii) raising public awareness about the potential value of NUS for food security, biodiversity protection, and poverty reduction in rural areas, and (iv) protection policies of plant genetic wealth. According to Will (2008), "only about 30 plant species out of the global agricultural biodiversity are used to meet 95% of the world's food energy needs." Therefore, investing and establishing the market value of locally based NUS can have the effect of shielding rural economies from globalization currents, commodity price volatilities, and food

TABLE 18

TOTAL EGYPTIAN EXPORTS OF ORGANIC PRODUCTS (TON)

| Crop   | 2000  | 2004   |
|--|-------|--------|
| <b>Cotton</b>  | 1,159 | n.a.   |
| <b>Legumes (onion, potatoes, garlic, green peas)</b>                   | 5,850 | 30,000 |
| <b>Aromatic &amp; medicinal plants (fennel, basil, wormwood, mint)</b> | 78    | 160    |
| <b>Fruits (strawberry, grapes)</b>                                     | 26    | 40     |

n.a.: Not available  
Source: Hamdi, 2006





import bans. Rehabilitating NUS will also contribute to preserving traditional knowledge and nutrition.

#### **iv. Drought resistant crops**

Research into conventionally bred and genetically modified drought-resistant cultivars and salt tolerant crops is essential for keeping rain-fed agriculture economically viable (El Obeidy, 2006). Arab governments should invest more in R&D activities to develop drought resistance crop varieties suited to their local environments. In this regard, Arab governments should adopt an aggressive approach in funding innovation efforts across a variety of key technologies as part of a risk management approach dictated by failures in climate policy and technology transfer. As pointed out by Tomlinson et al. (2008), failure to incorporate these potential scenarios into future mitigation plans will dramatically lower the likelihood of successful climate stabilization.

#### **v. Drought mitigation and early warning forecasts**

About 88% of arable land is in semi-arid areas, receiving an annual rainfall between 200 and 600 mm, as Table 17 indicates. Drought has long been a significant factor in the West Asia and North Africa region, particularly for low-rainfall

crop-livestock systems and for herders in the vast grazing areas of the steppe (Hazell et al., 2000).

In addition, climate change threatens land and water resources and cannot be ignored any longer. Adaptation to climate change must be accounted for in any agricultural plans and investments in order to mitigate the disruptive effects of droughts, variable rainfall, higher temperatures, and species redistribution.

With respect to risk management, droughts increase the level of indebtedness by rainfed farmers, who borrow to finance their agricultural production, which in turn puts agricultural financial institutions at risk after repeated drought occurrences. In Morocco, since 1999, the Public Agricultural Bank (CNCA), which finances more than 80% of all agricultural loans, has made the purchase of drought insurance a mandatory condition for obtaining an agricultural loan in drought prone areas (World Bank, 2001).

Most of the drought-coping strategies implemented by governments of the Arab region have focused on mitigation measures and emergency plans. With greater population growth rates and higher demand on declining water resources, governments need to address the drought as a structural phenomenon. 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 (Shobha, 2006).

In principle, the ability to provide early warning forecasts of drought could be a powerful tool for avoiding many of the economic costs associated with the misallocation of resources that arise when farmers, herders, and other decision makers have to commit resources each year before key rainfall outcomes are known. The economic value of season-specific forecasts depends indeed on the degree to which farmers can adjust their plans as the season's rainfall unfolds. If most decisions have to be made upfront each season, the scope for mistakes will be much greater and the potential economic gains from reliable forecast information will be forfeited (Hazell, 2000).

“Many governments have intervened to help manage drought losses, but usually on the basis of crisis relief once the drought has set in. Since the primary motive is typically humanitarian

assistance, not much thought is given to the longer-term impacts of drought interventions on farming practices and productivity. The result is often an inappropriate set of economic signals to farmers and herders, leading to unsustainable farming practices in many drought-prone areas that increase both future drought losses and government's cost of providing drought compensation” (Hazell, 2000).

All Arab countries have experienced, and continue to experience, high population growth rates and increased pressure on land and water resources, which threatens the sustainability of current land uses and exacerbates the impact of drought on rural populations (DePauw, 2000). The region has an overwhelming need for modern and effective drought early warning systems to enhance the ability of governments to plan for future water shortages in a region where instrumental weather records go back less than 50 years, and which has experienced a resurgence of devastating droughts.



### G. Promoting Organic farming

Organic farming is a form of agriculture that relies on ecosystem management and attempts to reduce or eliminate external agricultural inputs, especially synthetic ones. It is a holistic production management system that promotes and enhances agro-ecosystem health, including biodiversity, biological cycles, and soil biological activity.

Heavy agricultural reliance on synthetic chemical fertilizers and pesticides is having serious impacts on public health and the environment (Pimentel et al., 2004). Organic and agro-ecological farming can significantly increase yields for resource-poor farmers, improve food security, and sustain and enhance the environmental resources.

#### i. Current status of organic farming production in the Arab region

Compared to the status of organic agriculture worldwide, the Arab region is lagging behind what could be a vital and promising sector. Egypt is by far the most advanced country in terms of organic agricultural development in the Arab region. The total acreage of organic farming in Egypt is 24,548 hectare (Willer and Yussefi, 2006), as indicated in Figure 8.

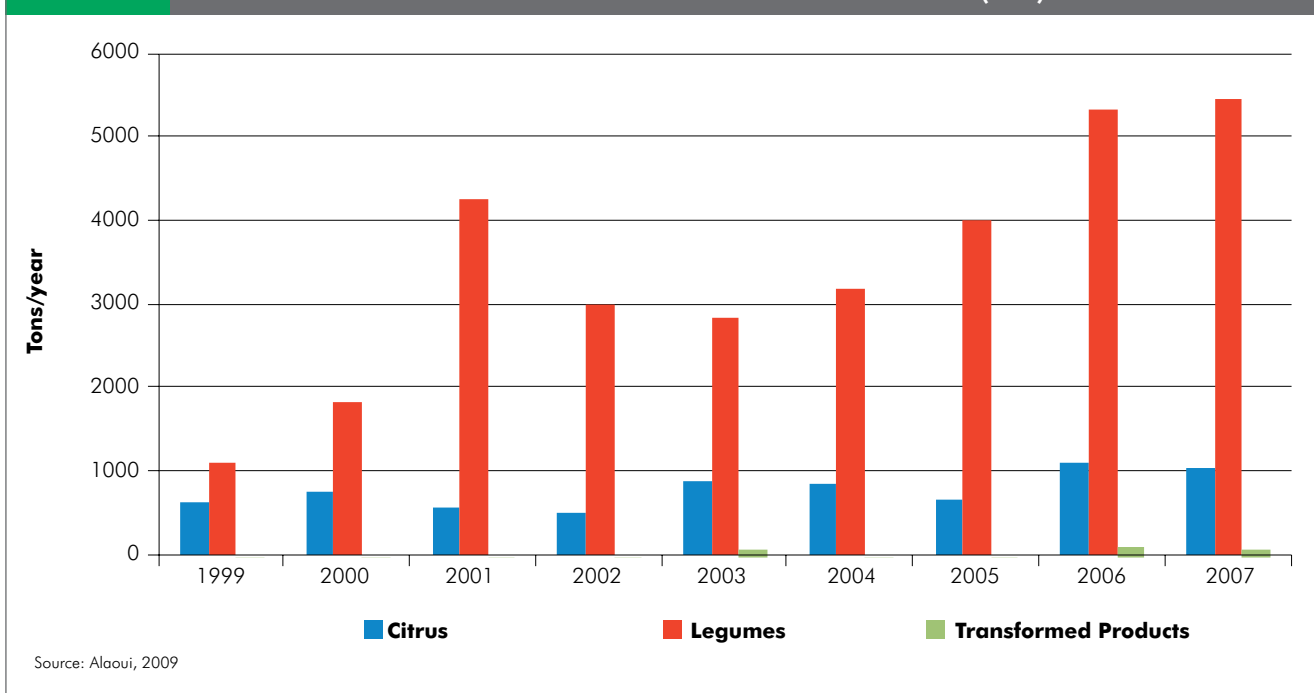
The main organic crops include fresh vegetables, tropical fruit trees, cotton, herbs and spices, medicinal plants, and cereals (Willer and Yussefi, 2006). Table 18 demonstrates remarkable growth in Egyptian exports of selected organic products

Organic agriculture has been practiced in Tunisia since the 1980s, with a total area of 335,897 hectare under cultivation (CTAB, 2011). Production and exports of Tunisian organic products are indicated in Figures 9 and 10, respectively.

According to EACCE (2007) and further estimates, the acreages of certified organic farming in Morocco has increased from 200 hectare in 1997 to 5,955 hectare in 2007, as indicated in Figure 11.

There are about 331 organic farms in Lebanon covering an area of 2,490 hectare, as of 2006 (ALOA, 2011). There are about 3,256 farms practicing organic farming in Syria, with a total certified acreage of 28,461 hectare (CIHEAM, 2008). Syria exports about 1,302 tons of organic cotton annually at a 30% higher premium than what the local market commands (MAAR, 2011). Organic agriculture in Algeria is in its infancy and has been launched in the country by state owned agencies.

FIGURE 11 EVOLUTION OF MOROCCAN ANNUAL EXPORTS IN ORGANIC PRODUCTS (TON)







## **ii. Current consumption of organic products and how to improve it**

Unfortunately, organic agriculture in most large producing Arab countries is being developed primarily for export. Egypt exports between 40% and 50% of its organic produce (FAO, 2006b). Seeking to raise consumer demand, promote organic value chains, and establish market linkages in Saudi Arabia, the Department of Organic Agriculture in Saudi Arabia is preparing a market development program for organic agriculture. The local consumption of agricultural organic products in Morocco and Tunisia is still limited because the sector is export-oriented. Arab governments should pursue the development of local markets for organic produce.

## **iii. Organic processing**

Organic processing in Lebanon is mostly focused on production of foods typically used in Lebanese cuisine, such as organic olive oil, oregano mix, orange blossom water, and traditional Lebanese

jams and recipes (ALOA, 2011). Olive is the main organically produced commodity processed in Tunisia. Organic wild capers in salt, organic Tunisian Harissa or hot pepper, and organic sugar cane are also produced. Except for Argan oil, most organic products produced in Morocco are exported without any processing.

## **iv. Certification of organic products**

Most Arab countries do not have their own certification and inspection bodies. Having such institutions would: (i) lower the cost compared with that of international inspection and certification, (ii) allow continuous capacity building for national inspectors and operators, (iii) reduce language barriers, (iv) offer competitive cost of laboratory analysis, and (v) motivate more farmers to convert to organic farming.

## **v. Future perspectives of organic agriculture**

Until now, most Arab countries have not taken





practical measures to promote organic agriculture at a large scale, while neighboring countries in Europe and Africa are promoting rapid growth in the sector. Arab countries are urged to implement their own certification processes. To promote domestic production and consumption of organic food, Arab countries should offer incentives to assist farmers make the conversion to growing organic crops. Because of the scarcity of organic fertilizers and bio pesticides and their high prices in the market, it is becoming urgent to offer incentives for the private sector to make these products more available and affordable. This can be achieved by exempting these products from import taxes and by promoting their production locally. Special effort should be made by all Arab countries to develop organic fertilizers and bio-pesticides as an alternative to the intensive use of conventional agrochemicals. Producers and

consumers of organic products should develop plans to expand the value chain for their products (Alaoui, 2009).

## **V. CONCLUSION AND RECOMMENDATIONS**

Agriculture in the Arab region has reached a precarious state driven over time by inappropriate policies and agricultural malpractices. Its capacity to continue to perform its economic, social, and environmental functions is at great risk. While agriculture has been a significant activity in the structure of most Arab countries' economies, its achievements have been undermined by a mix of problems manifested in various phenomena on the ground such as soil erosion, land degradation, loss of biodiversity, desertification, salinization,

water pollution, and depleted aquifers in various areas in the Arab region.

Irrigation potential in Arab countries is limited. Agriculture already uses over 85% of available natural water resources with an efficiency of less than 50%, while demand for industrial and domestic uses is on the rise. Emphasis on water supply rather than demand management, and the lack of appropriate laws, regulations, and incentives have created the conditions for improper practices such as the inefficient use of irrigation water, with detrimental consequences on environmental resources and biodiversity.

Against this background, and in an arid and semi-arid region, where agricultural land is limited and water resources are critically scarce, Arab countries have pushed up agriculture to the top of their development agenda with the aim of enhancing food security. It is imperative that a new approach to agricultural development with specific action plans is adopted to position agriculture on a sustainable path. To this end, Arab governments are urged to design comprehensive agricultural development strategies focusing on the following:

#### **a. Water Resources**

Water is an essential agricultural resource. Its critical scarcity in the Arab region will be further exacerbated by the potential impacts of climate change. A shift of focus from supply to demand management of water resources is critically important. Appropriate laws, regulations, and policies are needed to maintain the sustainability of surface and ground water resources and to ensure their efficient utilization, particularly in irrigation, with emphasis on water productivity rather than yield maximization per unit of land. In this regard, rational water pricing should be adopted to motivate prudent water use and to generate revenues that can be used to finance the maintenance and operation of agricultural infrastructure. Modern irrigation techniques such as sprinkler, drop, and localized irrigation can greatly enhance the efficiency of water use and prevent water logging.

In addition, more efforts should be made to augment water resources from non-conventional sources including harvesting, drainage, and treated

wastewater, while adopting required precautionary measures to ensure safety of use.

#### **b. Agricultural Productivity**

Crop productivity, especially that of cereals, grain legumes, and fodder crops, is at a very low level in the Arab region. Raising productivity and crop diversification are key to food security and to the financial and economic viability of agricultural investments. The limited irrigation potential and the dominance of rain-fed agriculture in the Arab region call for undertaking actions to promote the productivity of rain-fed crops. This objective can be achieved if appropriate quality inputs become available and are used in measured quantities. In this regard, research is an indispensable core activity for arriving at the optimal mix of inputs, and discovering drought-resistant cultivars and salt tolerant crops.

#### **c. Food Security**

Food security on a country level in the Arab region is unattainable. Prospects for making progress towards food security at the regional level require concerted and coordinated efforts of Arab countries and their cooperation to utilize land and water resources according to their comparative advantage. It is equally important to adopt policies that facilitate trade in agricultural commodities, and at the same time build the infrastructure necessary to access each other's markets.

#### **d. Investments and Financing**

Agriculture is an under-financed sector in the Arab region in terms of spending levels on infrastructure and research and development. Large sums of funds are required for both rehabilitation and development, in addition to funding research programs. It is utterly important that Arab governments introduce laws and policies to create an environment conducive to local and foreign direct investment, and to design agricultural investments attractive for private and public-private partnerships. Official development assistance remains a significant source of financing agricultural operations, especially because of its leveraging effect on the overall cost of capital. Assigning priority to agricultural investments supported by well studied and prepared projects

can be an effective vehicle for accessing ODA resources from national, regional, and international financing and development institutions.

### **e. Integrated Approach**

Past agricultural operations were often designed and implemented in a fragmented manner, lacking the supportive and facilitative components for achieving economic, social, and environmental objectives. It is essential that agricultural operations are not confined to production aspects, but be broadened enough to incorporate associated supply chain facilities and services such as transportation, packaging, storage, and marketing to bring produce and other commodities to consumers without loss in quantity or deterioration in quality.

### **f. Environmental Considerations**

Agricultural policies and practices in the Arab region have often been unmindful of the protection of natural resources or ecosystems. New eco-agricultural methods, protective of soils, land, and water, such as organic and conservation farming methods should be promoted and supported. Furthermore, climate change necessitates the need for building suitable mathematical models for forecasting local and regional climate changes to assess their impact on agricultural resources and products, and introduce adaptation measures accordingly.

### **g. Farmers**

The complexity of agriculture and its scientific applications demand those involved in practicing farming, especially farmers to possess the skills, knowledge, and expertise to make the right decisions regarding seed selection, fertilizers, pesticides, irrigation techniques, and other related farming disciplines. Therefore, it is critically important to train farmers and equip them with the necessary education, skills, and knowledge to build up their capacity to deal with ensuing issues. Establishing agricultural cooperatives and service centers for extension and training as well as assisting farmers in accessing markets for their products are necessary for supporting farming activities and enhancing livelihoods in rural areas. Farmers should also be organized to facilitate learning and sharing of farming practices that contribute to agricultural sustainability.

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