Food Security and Water Poverty in Central and West Asia and North Africa Region

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Summary

All countries in Central and West Asia and North Africa (CWANA) region in general, and WANA region in particular, have faced severe challenges in increasing their agricultural production over the last 40 years. This is mainly due to many factors, including a limited natural resource base of arable land and water, low and erratic rainfall with frequent drought, growing population, low rates of productivity growth, increased rural-urban migration, low public and private investments in rainfed areas, weak extension systems, inappropriate agricultural policies and low adoption rates of new technologies. CWANA has achieved 2.9% annual growth rate in cereal production during the 1962-2002 period. Most of the growth is attributed to productivity enhancement in the first place and to area expansion in the second place. Cereal yield and area grew by 1.5% and 1.3% during the same period, respectively. Likewise, the region has achieved growth in pulse production at an annual rate of 1.6%, which is largely originated from area expansion. Only 20% of growth in pulses production is attributed to yield increase.

Food consumption pattern is expected to change dramatically during the next 20 years in response to increases in population, per capita income and changes in consumer preferences. Meat per capita consumption is projected to increase rapidly, by 29% for poultry and 19% for beef between 1997 and 2020. Per capita consumption of other livestock products will increase as well. Only the per capita consumption of two major cereal commodities, wheat and maize, is projected to decrease by 2% and 16%, respectively. This reduction in wheat and maize per capita consumption will only slightly contribute to grain deficit reduction in CWANA region. Total grain deficit in CWANA region is expected to decrease from 46 million tons in 2002 to 35 million tons in 2020.

Available information on water poverty index (WPI) and its sub-indices are used to monitor the performance of scarce water in CWANA region. They suggest that water resources are misused and not sustainably managed in CWANA region. In addition, people in the region do not have adequate access to the available water resources. Food security indices were compared to water poverty index using correlation and regression analyses. Results clearly show that positive correlation is found between water scarcity and food security index, suggesting that food security is associated with water availability. Regression analysis indicates that water poverty explains nearly 43% of the variation in food security. This study provides evidence on the importance of studying the food security alongside the water poverty in CWANA region. Having water scarcity contributing to nearly half of the variation in food security will have important policy, research, and investment implications. Food insecurity is greatly explained by water poverty, and thus the two problems need to be addressed as interrelated and in an integrated approach. Both problems require immediate and equal attention at various policy and managerial levels.

Key Words: Food security; Water poverty; CWANA; Consumption, production & growth.

Introduction

Food demand growth caused by expanding populations and shifting consumption patterns will necessitate future food production increases, but unexploited, available land is limited, placing increased pressure on technologically driven yield improvements (Rosegrant *et al.,* 2001). Growing urban and industrial demands on existing water supplies and the need for improved water quality further complicate the situation.

Growth rates of world agricultural production and crop yields have slowed in recent years. This together with weak systems of food distribution has raised fears that the world may not be able to provide enough food and other commodities to ensure that future populations are adequately fed. In many societies, including Central and West Asia and North Africa (CWANA) region, the problem of resource redistribution represents an important part of the problem of poverty and food shortage, both currently and in the long run.

CWANA is characterized by high population growth; low and erratic rainfall; limited areas of arable land; and severely limited water resources for further development of irrigation. Therefore, methods for more efficient and sustainable use of these limited resources must be found. Cereal production has increased by 80% since 1979-81, especially in Egypt and Morocco, due mainly to increased wheat yield. The modest increase in barley production is the result of area expansion and yield increases (IFAD, 2002). The number of small ruminants has grown greatly throughout the region, resulting in doubling meat production. Regardless of these gains, the food gap is expected to grow by 2.9% per year throughout the coming decade.

Past policies in the region, in general, have led to environmental degradation while doing little to improve the livelihoods of the rural poor. Agricultural sectors and rural communities face severe natural resources and institutional constraints. Main natural resource constraints are fragile land resource base and declining soil fertility, limited water resources and growing water scarcity, and frequent climate shocks (e.g. drought). The institutional constraints include unequal land distribution and insecure land tenure, poor and unstable management of common resources, low public sector investment in physical and social infrastructure in the rural areas, lack of active and effective local institutions, and

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low adoption rates of improved technologies and practices. In many countries of the region, the agricultural sector is in state of transition from heavily controlled by the state to being largely driven by market forces. However, some socially driven policies, such as consumer food subsidy, subsidized credit and agricultural inputs, and price support measures are still in place in some countries. Farmers are obliged to sell their output to state at fixed prices, which are either higher or lower than market prices. Economically, the policies of subsidies and market controls led to market distortion, inefficient allocation of resources, and stagnation of the agricultural economy.

Growth rates of GNP in the 1990s varied considerably among countries. Algeria and Morocco experienced the lowest growth rates of 1.6% and 2.3%, respectively, whereas Lebanon and Syria achieved the highest growth rates of 7.7% and 5.7%, respectively. The remaining countries in the region have experienced moderate growth rates in the GNP, ranging from 3.2% in Yemen to 4.6% in Tunisia. Due to high population growth rate of 2.3% during the 1990s, these favorable growth rates resulted in only a small net improvement (IFAD, 2002). Among the CWANA region, the Near East and North Africa (NENA) sub-region has been characterized by persistently high population growth rates, averaging at 3.1% in the 1980s. Although the population grew slowly in the 1990s at an annual rate of 2.3%, the labor force is still growing at more than 3% annually as a result of previous population growth (IFAD, 2002). Rural population, on average, accounts for about 47% of the sub-region entire population. However, rural population represents nearly 20% of total population in Djibouti and Lebanon, and about 66% in Somalia and Sudan.

The contribution of agricultural sector to the national economies is low (about 16%), despite the fact that nearly 36% of the active population is engaged in agriculture. This low contribution to the national economies is mainly attributed to low productivity and poor integration of rural population with the rest of the economy. Agricultural sector in Jordan contributes only 3% to national economy, whereas in Sudan the contribution is much more higher (40%). In most other countries, the contribution of agriculture to GDP ranges between 10-20% (IFAD, 2002). However, agriculture is a major market for labor in many countries. The proportion of active population engaged in agriculture varies from 4% in Lebanon to over 70% in Somalia, with an average of 30% for other countries. All countries, except Turkey, Syria and Tunisia are food deficit and thus, depend on imports in varying degrees. The main objectives of this study are to analyze and describe trends in food production and consumption in CWANA region, and to assess the relationship between food security and water poverty in the region. Results of this study have important research, investment, and policy implications.

Food Security at the Globe

There are three main sources of growth in crop production, which are expanding the land area (horizontal expansion), increasing the frequency with which land is cropped (often through irrigation), and boosting yield (vertical expansion). It has been suggested that the world may be approaching the ceiling of what is possible for all three sources. A detailed examination of production potentials does not support this at the global level, although in some countries and sub-regions, serious problems already exist and could deepen.

Irrigation is crucial to the world s food supplies. In 1997-1999, irrigated land made up only about one-fifth of the total arable area in developing countries but produced two-fifths of all crops and close to three-fifths of cereal production. The role of irrigation is expected to increase still further. The developing countries as a whole are likely to expand their irrigated area from 202 million ha in 1997-99 to 242 million by 2030. Most of this expansion will occur in land-scarce areas where irrigation is already crucial. FAO studies suggest a total irrigation potential of some 402 million ha in developing countries, of which only half is currently in use. However, water resources will be a major factor constraining expansion in South Asia, which will be using 41% of its renewable freshwater resources by 2030, and in the Near East and North Africa, which will be using 58%. These regions will need to achieve greater efficiency in water use.

Yield growth continues to be the dominant factor underlying increases in crop production in the future. In developing countries, it will account for about 70 percent of growth in crop production to 2030. To meet population projections, future yield growth will not need to be as rapid as in the past. For wheat yields, an annual rise of only 1.2 % a year is needed over the next 30 years. Overall, the FAO estimated that nearly 80% of the future increase in crop production in developing countries will have to come from intensification, higher yields, increased multiple cropping and shorter fallow periods. Productivity increases are still vital, but must be combined with environmental protection or restoration, while new technologies must be both affordable by, and geared to the needs of the poor and undernourished.

Diets in developing countries are changing as incomes rise. The share of staples, such as cereals, roots and tubers, is declining while that of meat, dairy products and oil crops is increasing. Between 1964-66 and 1997-99, per capita meat consumption in developing countries increased by 150 %, and that of milk and dairy products by 60 %. By 2030, per capita consumption of livestock products could rise by 44 %. As in the past, poultry consumption will grow fastest.

Food security indicators of 70 low-income developing countries show slow improvement if in their food security over the next decade. A USDA study showed that average per capita food consumption of these countries stagnated in 2002, and the number of people not meeting nutritional requirements was estimated to be higher than in 2001 (USDA, 2003). Instability in short-run food production continues to hamper long-run food security progress as poor countries tend to focus their policies and resources toward dealing with emergencies when they faced with frequent economic shocks. This has raised concerns about the attainability of the 1996 World Food Summit goal to halve the

number of hungry people by year 2015. In fact, the food security situation for some countries, as in Sub-Saharan Africa, has worsened since 1996 (USDA, 2003). In its response to these concerns, the World Food Summit in 2002 called for more resources to battle hunger and food insecurity. Similar efforts were taken by other international forums such as the WTO meeting in Doha (July 2002), and the Summit on Sustainable Development in Johannesburg (August 2002). The situation is further complicated by food production shortfalls, a global economic slowdown that intensifies foreign exchange constraints and thus reduces purchasing power of consumers and worsens poverty, and grain price increases that limit a country s ability to import food.

World wheat net trade is projected to increase by 3.6% annually, reaching 104.2 million tons by 2012/2013 (Table 1). Growth in imports from developing Asian and Middle Eastern countries accounts for most of this increase because of rising demand and limited potential to increase production. African and Middle Eastern countries make up more than half of the market for wheat imports, and they are the second fastest growing market for wheat (FAPRI, 2003). Egypt s net imports, for example, grow by 2.4% annually, reaching 7.9 million tons in 2012/2013, because of low prices and higher per capita consumption. Similarly, Iran s net imports increase by 3.6% per year, reaching 4.8 million tons in 2012/2013.

World barley demand increases steadily at an annual rate of 4%, fueled by growing demand from China and Saudi Arabia. Beef trade is projected to grow by an annual growth rate of 3.01% in the next decade after a two-year decline in its trade due to BSE and FMD diseases. Beef production is also expected to increase by 1.5% annual growth rate, reaching 54.71 million tons in 2012. Recovery in major importing countries, such as Mexico and Russia will slightly reduce growth in trade in the next decade, and trends ends at 4.14 million tons in 2012 (FAPRI, 2003).

Table 1. World trade of wheat, barley, and beef and veal (total net imports, million tons)

Year	Wheat	Barley	Beef & Veal
2002/03	73.37	12.71	3.25
2003/04	76.99	14.82	3.46
2004/05	84.18	16.02	3.73
2005/06	89.43	16.16	3.87
2006/07	91.85	16.94	3.99
2007/08	94.30	17.30	4.05
2008/09	95.99	17.87	4.08
2009/010	97.92	18.26	4.12
20010/011	100.13	18.56	4.16
20011/012	102.17	18.97	4.17
20012/013	104.18	19.26	4.14

Source: FAPRI (2003).

Projections made by IFPRI for production in 2020 suggest that many of the major commodities remain critical for developing countries access to food. Rising food deficits in WANA region are important in wheat, rice, maize, and fish. Deficit in beef in WANA is predicted to be important. Toward 2030, according to the FAO, the most serious imbalances for cereals will be experienced in wheat and coarse grains in WANA, East Asia, and Sub-Saharan Africa, respectively. The primary means through which increased yields will be met is through increased intensification and technological efficiency in reducing yield gaps. New science has an important role to play in meeting these needs. Changes in the commodity composition of food are expected to occur in developing countries with a relative stabilization of per capita consumption of cereals, roots and tubers, and pulses, and marked increases in vegetable oils, meat and milk and dairy products. There will need to be relatively large increases in the production of meet (beef and veal, mutton and lamb, and poultry meat) in developing countries.

Food Production and Consumption in CWANA Region

Food Production in CWANA Region

All countries in CWANA region in general, and WANA region in particular, have faced severe challenges in increasing their agricultural production over the last 40 years. This is mainly due to many factors, including a limited natural resource base of arable land and water, low and volatile rainfall with frequent drought, growing population, low rates of productivity growth, increased rural-urban migration, low public and private investments in rainfed areas, weak extension systems, inappropriate agricultural policies, and low adoption rates of new technologies. Total land area in CWANA region is 2.3 billion hectares, the arable land is about 170 million hectares or 7% of the total area of the region. Irrigated land made up about 35% of the arable land in CWANA in year 2002. In Armenia, Egypt, Kyrgyzstan, Oman, Pakistan, Turkmenistan and Uzbekistan irrigated land ranged between 80 and 100% of the arable land. Ethiopia irrigated land is only 2% of the arable land in year 2002, which indicates a high potential of increasing crop productivity by increasing irrigated land in the country. Government policies have helped to expand agricultural production, but at the expense of deteriorating the natural resource base. Most policies have been directed to increase cereal and meat production, which include highly subsidized fuel and credit for machinery and other modern inputs, high support prices for producers, high producer and consumer subsidies, and high tariffs on imported food commodities. To better understand the status of food production in CWANA region, a trend analysis was conducted for major cropping groups using FAO data in 1961-2002. Results are summarized below by commodity groups.

Cereals:

Growth performance of CWANA's cereal production over the last four decades has been impressive. Data in Table 2 show that CWANA has achieved 2.9% annual growth rate in cereal production during the 1962-2002 period. Most

of the growth is attributed to productivity enhancement in the first place and to area expansion in the second place. Cereal yield and area grew by 1.5% and 1.3% during the same period, respectively. Highest production growth rates occurred in the 1960s (3.4%) and the 1970s (2.7%), mostly attributed to high yield growth rates of 2.1% and 2.5%, respectively. The contribution of yield to the growth of cereal production decreased during the 1980s and 1990s. However, the CWANA region has maintained an annual growth in cereal production of 2.1% during the last two decades (Table 2). This is mainly attributed to substantial investments made by oil-producing countries during the 1980s, which skewed overall regional growth upward. Saudi Arabia, for example, has expanded its cereal production substantially through massive investments in irrigation, using nonrenewable water supplies and heavy application of subsidized fertilizers.

Table 2. Cereal growth rates in CWANA region, 1961-2002

Period	Growth Rates (%)		
	Area	Yield	Production
1961-69	1.4	2.1	3.4
1970-79	0.2	2.5	2.7
1980-89	0.9	1.1	2.1
1990-02	0.7	1.1	2.1
1961-02	**1.3**	**1.5**	**2.9**

Source: Shideed, and Shomo (2005). Estimated based on FAO database.

Cereal production performance during the last four decades was particularly strong in Egypt (3%), Iran (3.5%), Kyrgyzistan (3.1%), Pakistan (3.5%), Saudi Arabia (7.6%), Syria (3.7%), Tajikistan (7.7%), Turkmenistan (9%), and Uzbekistan (7.7%). Data in Table (3) clearly demonstrate that the source of cereal production growth varies among countries. Yield increase has been the major source of cereal growth in most of CWANA countries, including Azerbaijan, Egypt, Iran, Krygyzistan, Pakistan, Saudi Arabia, Syria, and Uzbekistan. Area expansion has been the main contributor to cereal growth in Armenia, Georgia, Tajikistan and Turkmenistan. Cereal production decreased annually in four countries, including Afghanistan (-0.9%), Jordan (-2.3%), Kazakhstan (-4.7%), and Yemen (-1.1%). Other countries have achieved a moderate growth in cereal production during the last 40 years.

The highest production growth rate for barley was recorded in Iran (3.77%) and the lowest in Turkmenistan. In general all Central Asian Republics recorded negative growth rates in barley production, which can be attributed to decrease in planted areas as result of changing the cropping pattern in these countries and shifting to wheat, which recorded high production growth rates. Turkmenistan, Uzbekistan, Tajikistan, Saudi Arabia reached the highest growth rates in wheat production of 17.71, 17.70, 12.73, 11.26% respectively. Armenia, Azerbaijan, Georgia, Kyrgyzstan and Sudan reached high production growth rates in wheat production between 6.84 and 5.10%. Other countries such as Egypt, Iran, Libya, Mauritania, Pakistan, Syria and Yemen

Table 3. Cereal growth rates (%) in CWANA countries, 1961-2002

Country	Area	Yield	Production
Afghanistan	-1.4	0.2	-0.9
Algeria	-1.0	1.5	0.5
Armenia	1.69	0.5	2.19
Azerbaijan	1.13	4.4	5.59
Egypt	1.0	2.0	3.0
Ethiopia	0.1	1.5	1.6
Georgia	5.23	-1.36	3.8
Iran	1.1	2.4	3.5
Iraq	1.1	-0.7	0.4
Jordan	-5.3	3.1	-2.3
Kazakhstan*	-6.3	1.6	-4.7
Kyrgyzistan*	0.8	2.2	3.1
Lebanon	-1.8	2.6	0.7
Libya	-1.5	3.0	1.4
Mauritania	-0.6	3.0	2.4
Morocco	0.7	0.3	1.0
Oman	-0.8	2.3	1.4
Pakistan	1.1	2.4	3.5
Saudi Arabia	3.1	4.4	7.6
Somalia	0.6	0.4	1.0
Sudan	4.0	-1.3	2.6
Syria	1.6	2.1	3.7
Tajikistan*	4.7	2.9	7.7
Tunisia	-0.7	1.9	1.2
Turkey	0.2	1.9	2.1
Turkmenistan*	8.2	0.8	9.0
Uzbekistan*	0.5	7.9	7.7
Yemen	-1.8	0.7	-1.1
CWANA Region	**1.3**	**1.5**	**2.9**

Source: Shideed and Shomo (2005): Estimated based on FAO database. * 1992-2002.

reported wheat production growth rates between 4.33 and 3.42%. Jordan, Kazakhstan and Oman reported negative wheat production growth rates. In Egypt, Georgia, Iran, Libya and Mauritania increasing the productivity of wheat was the main factor of increasing the production growth, but in other countries like Saudi Arabia and Sudan increasing the cultivation areas was the major cause of increasing wheat production.

Pulses:

Pulses are an important part of human diet in CWANA region and constitute the major protein source for the poor. Table (4) indicates that pulses production sustained an annual growth rate of 1.2% during the 1960s and 1970s. This growth rate is totally attributed to yield increase in the 1960s. However, output growth is totally attributed to the expansion of planted area during the 1970s. The CWANA region's highest growth in pulses production of 3.7% is totally attributed to the expansion of area by 3.7% annually during the 1990s. The region was able to stop the deterioration in pulses yield in the 1980s, but not capable to reverse it. In fact pulses yield demonstrated negative growth rate during the 1990s, contributing to production deterioration

during the same period. Overall, the CWANA region has achieved growth in pulses production during the last 40 years at an annual rate of 1.6%, which is largely originated from area expansion. Only 20% of growth in pulses production is attributed to yield increased, which is mainly occurred in the 1960s.

Table 4. Pulses growth rates in CWANA region, 1961-2002

Period	Growth Rates (%)		
	Area	Yield	Production
1961-69	-0.5	1.6	1.2
1970-79	1.3	-0.1	1.2
1980-89	3.7	0.0	3.7
1990-02	-0.3	-0.1	-0.4
1961-02	**1.3**	**0.3**	**1.6**

Source: Shideed, and Shomo (2005). Estimated based on FAO database.

For individual countries, however, differences in pulses production growth rate and its sources can be extreme. Three Central Asian countries achieved the highest growth in pulses production during the 1990s estimated at 16.3% for Kazakhstan, 5.2% for Turkmenistan, and 13.8% for Uzbekistan. Except for Iraq, Jordan, and Morocco, all other CWANA countries have experienced annual growth in pulses production. The annual growth rate of pulses production is 3.5% for Iran, 2.2% for Mauritania and Sudan, 1.0% for Syria, 2.1% for Tunisia, and 3.6% for Turkey.

Food Consumption in CWANA Region

Grain consumption growth in CWANA region was most rapid during the 1960s, 1970s, and 1980s. Grain demand growth declined in most of CWANA countries during the 1990s, while remaining strong in Egypt, Ethiopia, Lebanon, Sudan, and Tunisia. Grain demand growth between 1980-89 and 1990-2002 declined the most in Algeria, Iraq, Kazakhstan, Morocco, and Turkey. Declining population growth rates, saturation of demand, and declining oil revenues helped slow the overall growth of again demand in CWANA during the 1990s.

WANA had net cereal imports of 45.1 million tons in 1997 (Table 5). Despite the slowing of demand growth, net imports continued to increase in the 1990s. The growth rate of WANA s imports was not strongly related to the performance of the agricultural sector (Rosegrant *et al.*, 2001). Cereal exploding domestic demand is expected to increase WANA s cereal net imports to 73.1 million tons by 2020. Wheat imports alone, of 37.8 million tons, accounts for 52% of the total cereal net imports in 2020.

Similarly, imports of livestock products are projected to increase substantially during the next two decades. All meat imports are expected to increase from 0.946 million tons in 1997 to 1.767 million tons in 2020, among which beef and poultry account for 42% and 51%, respectively. Net imports of sheep and goat, milk, and eggs are also expected to increase sharply by 2020 as a result of increased demand for

Table 5. Production, consumption and trade for major commodities in WANA (million tons)

Commodity	1977			2020		
	Production	Consumption	Trade	Production	Consumption	Trade
Beef	1.388	1..747	-0.377	2.352	3.095	-0.744
Sheep& goat	1.769	1.845	-0.104	2.990	3.092	-0.102
Poultry	3.151	3.482	-0.459	5.765	6.670	-0.905
All Meat	**6.368**	**7.140**	**-0.946**	**11.196**	**12.962**	**-1.767**
Wheat	50.487	75.109	-25.91	73.194	110.967	-37.773
Rice	54.53	8.151	-3.069	8.275	13.418	-5.143
Maize	94.88	18.296	-9.703	13.413	27.777	-14.364
Other course grains	20.025	27.435	-6.400	27.592	43.423	-15.831
All Cereals	**85.453**	**128.991**	**-45.08**	**122.474**	**195.585**	**-73.111**
Egg	2.215	2.227	-0.10	3.507	3.574	-0.067
Milk	25.467	30.167	-4.885	41.424	49.289	-7.864

Source: Rosegrant *et al* (2001), p. 177, Table D.1.

livestock products due to population growth, changes in consumers preferences, and increased per capita income.

It is generally accepted that full food self-sufficiency is not attainable in the foreseeable future, if ever. And thus, WANA will remain a food and feed deficit region and thus depends on international markets to feed its growing population.

Food supplies in Algeria, Egypt, Morocco, and Tunisia are projected to be sufficient to meet nutritional requirements through 2012. Given the limited potential for expanding irrigated areas under increased water scarcity, it is expected that future growth will be slight, as yields have virtually peaked. Historically, imports grew by an annual rate of 2.4, but this growth is projected to slow down due to slow population growth. Population growth rate is expected to decrease from 2.3 % in the historical period to 1.5% over the next 10 years.

For Central Asian countries, the demand of both cereal and meat products are expected to rise by 3.37 million tons (31.58 percent change) and 0.91 million tons (47.7 percent change), respectively by the year 2020. It is projected that the per capita food availability will increase 6.1 percent as a whole for Central Asia from 2,685 calories per day in 1995 to 2,850 calories per day in 2020. In spite of the negative economic growth during the 1990s, all of the Central Asian countries are expected to have a 3% economic growth at least up to the year 2020 (Pandya-Lorch, 2000). Even with positive economic growth expected, the Central Asian countries will need to import some cereals and double their imports in meats in order to meet the food demand, which may not meet the quantity and quality of food needed for food security due to low purchasing power.

Changes in the Food Consumption Pattern of WANA Region

Food consumption pattern is expected to change dramatically during the next 20 years in response to increases in population, per capita income and changes in consumer preferences. Meat per capita consumption is projected to increase rapidly, by 29% for poultry and 19% for beef (An-

derson, 2002). Per capita consumption of other livestock products will increase as well. Milk and sheep/goat per capita consumption is expected to increase by 14% and 12%, respectively, between 1997 and 2020.

Only the per capita consumption of two major cereal commodities, wheat and maize, is projected to decrease by 2% and 16%, respectively. This reduction in wheat and maize per capita consumption will only slightly contribute to grain deficit reduction in CWANA region. Total grain deficit in CWANA region is expected to decrease from 46 million tons in 2002 to 35 million tons in 2020 (Table 6). Low growth rates of population, consumption, and yield in WANA may explain the anticipated decrease in grain deficit. The annual increase in the demand for cereals is expected to decrease to less than 2 % per year by 2020, which is lower than the annual growth rates of the 1980s and 1990s estimated at 4 % and 2.5%, respectively (Anderson, 2002). The rate of increase in production and yields are expected to decrease during the next 20 years. The cereal yields in WANA are expected to increase slightly during the next two decades, but they are still far below those of East Asia.

Table 6. Projections of population and grain deficit in CWANA region, 2002-2020

Year	Population (million)	Production (million tons)	Consumption (million tons)	Deficit (million tons)
2002	732.71	166.17	212.08	-45.91
2005	777.30	180.81	230.64	-49.83
2010	863.89	208.16	255.57	-47.41
2015	946.23	239.69	281.60	-41.91
2020	1036.02	276.01	310.77	-34.75

Source: Shideed and Shomo(2005): Estimated based on FAO database.

Data in Table (7) show that increases in production fall short than of increases in demand for cereals during the last 40 years. Annual growth rate of grain consumption in CWANA is estimated at 3.4 % during the 1961-2002 period,. Whilewhile, grain production has increased by an annual growth rate of 2.9 % during the same period. The increase in the demand for grain is partially explained by a modest population growth rate of 1.4 % annually during the last four decades. As a result, net cereal imports in WANA increased from about 6 million tons in 1967 to about 44 million tons in 2002, with a projection to increase to more than 70 million tons by year 2020 (Anderson, 2002). The rapid increase in net cereal imports is more evident for rice, wheat and maize. Net imports of rice are expected to increase by 65 % by year 2002-2020. Meanwhile, wheat and maize net imports will increase by nearly 50 % during the same period.

WANA meat position is not different, current level of net imports of 1 million tons per year is expected to increase to about 1.8 million tons by year 2020.

Water Poverty

The dry areas of West Asia and North Africa face severe and growing challenges due to the rapidly growing demand for water resources. New sources of water are increasingly expensive to exploit, limiting the potential for expansion of new water supplies. Irrigation accounts for 80 per cent of withdrawals region-wide, but demand is expanding most rapidly in urban areas. Withdrawals in the Libyan Arab Ja-

Table 7. Grain production and consumption growth rates in CWANA region, 1961-2002

Period	Growth Rates (%)		
	Area	Yield	Production
1961-69	1.6	3.4	3.1
1970-79	1.4	2.7	4.0
1980-89	1.0	2.1	3.1
1990-02	1.4	2.1	1.8
1961-02	**1.4**	**2.9**	**3.4**

Source: Shideed and Shomo (2005): Estimated based on FAO database.

mahiriya, Saudi Arabia, the Gulf States and Yemen already exceed renewable supplies, while Egypt and Jordan have essentially reached the limit; and Algeria and Tunisia face several regional deficits even if in total they are in surplus (ESCWA/ICARDA, 2000).

Water poverty is better measured by Water Poverty Index (WPI), developed by Center for Ecology & Hydrology and Department for International Development in the U.K, which measures countries relative position in the provision of water. WPI is an international measure comparing performance in the water sector across countries in a holistic manner (Lawrence *et al.,* 2003). It is linking household welfare with water availability and indicating the degree to which water scarcity impacts on human well being. The WPI consists of five main components, including resources, access, capacity, use, and environment (Lawrence *et al.*, 2003). This index is used by this study to study the relationship between food security and water poverty. Another important indicator for water stress is Falkenmark index, which measures water resource availability per capita per year. Based on this index, a per capita water availability of 1000-1600 m^3 indicates water stress, 500-1000 m^3 indicates chronic water scarcity, while a per capita water availability below 500 m^3 indicates a country beyond the water barrier of manageable capacity (Lawrence *et al.*, 2003).

According to Falkenmark Index (expressed as thousands of m^3 per capita per year) CWANA countries were grouped into three groups. The first group where the index ranges between 11800 and 1800 m^3 contains Tajikistan, Kyrgyzstan, Turkmenistan, Kazakhstan, Sudan, Turkey, Pakistan, Mauritania, Iran and Ethiopia. The second group includes Syria, Lebanon, Eritrea, Uzbekistan and Morocco with Falkenmark index ranges between 1600-1100 m^3. The last group with the index range between 400 and 100 m^3 contains Oman, Tunisia, Algeria, Egypt, Yemen, United Arab Emirates, Saudi Arabia and Jordan.

Available information on water poverty index (WPI) and its sub-indices (resources, use, access, capacity, and environment) are used to monitor the performance of scarce water in CWANA region. Although, a negative association between resources and use is to be expected a priori (the more scarce the resources, the better use is made of them), the positive correlation between these two indicators of 0.30 suggests that water resources are misused in CWANA region. Similarly, the positive correlation of 0.21 between resources and environment is not consistent with a priori expectations of negative association (the more scarce the resources, the more attention is paid to conservation generally), indicating that water resources in the region are not sus-

tainably managed. The negative correlation between resources and access sub-indices also contradicts with what one might have expected, suggesting that people in the region do not have adequate access to the available water resources. There is positive association between the WPI and the human development index (HDI) for CWANA countries.

WPI sub-indices reveal that water availability (resources) is the most limiting factor to the development of water sector in all CWANA countries, except Eritrea, Ethiopia, Kazakhstan, Kyrgyzstan, and Sudan. For Eritrea and Ethiopia, improving population access to clean water and sanitation and enhancing access to irrigation would be more productive investments to improve the efficiency of water sector. However, environmental attributes, such as water quality, water pollution, regulations, and information capacity are the priority areas for interventions in Kazakhstan, Kyrgyzstan, and Sudan.

Another important indicator to better understand the status of managing irrigation water resources is water use efficiency. Available information indicates that scarce water resources are poorly managed and inefficiently used in the dry areas of CWANA region. Irrigation accounts for 80-90 per cent of all water consumed in the region, thus, improving on-farm water-use efficiency (FWUE) can contribute directly to increased availability of water. Six empirical studies on economic assessment of FWUE in agriculture, jointly conducted by ICARDA and ESCWA, demonstrate the low ratios of water-use efficiency in crop production (ESCWA/ICARDA, 2000, 2001 and 2003)[1].

Empirical results of FWUE in Egypt, Iraq, Jordan, and Syria using farm level data, reveal important information (Shideed *et al.*, 2005). When the amount of water required for the crops was compared with actual amount used, it was found that there was over-irrigation for all crops and in all the study areas. FWUE for wheat, for example, was found to be 0.61 in Radwania (Syria), 0.37 in Rabea (Iraq), 0.65 in Nubaria and Beni Sweif (Egypt), 0.30 in Al Ghor (Jordan), and 0.77 in Ninavah (Iraq) (Fig. 1). These estimates indicate that farmers over-irrigated wheat by 20-60%. It is, therefore, possible to save an enormous amount of water which can be used to expand the wheat growing area, and thus increase total production, or to produce other crops. Alternatively, farmers can increase the wheat yield considerably under current levels of water use, and with improved water and crop management practices. Either option can contribute greatly to food security in WANA.

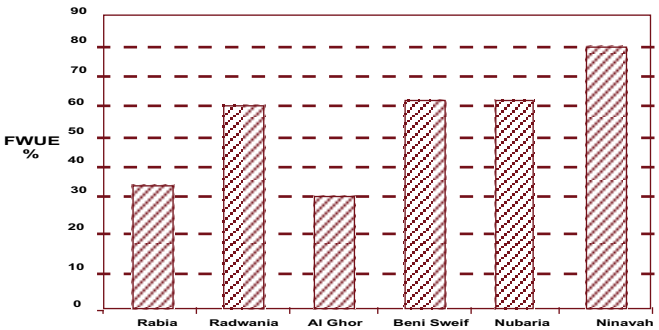

Fig. 1. Wheat FWUE (%) in selected areas in WANA.
Source: Shideed *et al* (2005).

1 FWUE is defined as the ratio of the amount of water required to actual amount of water used to produce a specific level of output.

Likewise, estimates of FWUE under full irrigation provide important information on the efficiency of water use in producing competing crops. Cotton FWUE was estimated at 0.75 in Radwania and Beni Sweif, reflecting relatively high water-use efficiency compared to other crops produced in these two areas (Fig. 2). However, cotton producers exceeded crop requirements by nearly 25%, an amount that could be saved if farmers were provided with extension recommendations to rationalize the use of scarce water. Likewise, FWUE of two forage crops, bersem and corn, produced under full irrigation in Egypt was estimated at 0.72-0.76, suggesting high water-use efficiency in the production of these two crops. These estimates are higher than those of competing crops, 0.55 for faba bean and 0.64 for sunflower--produced under similar conditions in Egypt.

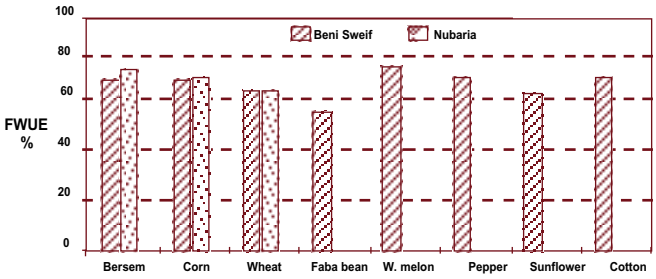

Fig. 2. FWUE of competing in Beni Sweif and Nubaria, Egypt.
Source: Shideed *et al* (2005).

The estimates of FWUE of vegetable reflect a low efficiency level in using irrigation water. Tomato FWUE, for example, was estimated at 0.68 in Rabea-Iraq, 0.53 in Al Ghor-Jordan, 0.56 in Beni Sweif-Egypt, and 0.69 in Nubaria-Egypt (Fig. 3). The FWUE of watermelon was estimated at 0.76 and 0.44 in Nubaria-Egypt and Al Ghor-Jordan, respectively. Similarly, the estimates of pepper FWUE were 0.74 and 0.53 in the same two areas, respectively. FWUE for cucumber and eggplant was 0.56 and 0.66, respectively, in Al Ghor-Jordan.

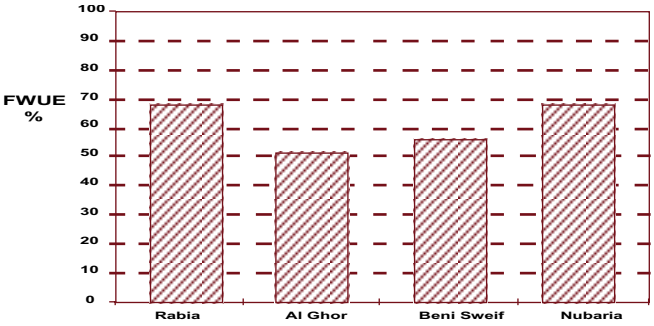

Fig. 3. Tomato FWUE in selected areas in WANA.
Source: Shideed *et al* (2005).

The estimates of FWUE for cereal, industrial, and vegetable crops mentioned above indicate a wide technological gap between the required practices and actual water application. Therefore, improving water-use efficiency for these crops can contribute greatly to the overall water-use efficiency in the study areas, and offers a high potential for saving water. These results are consistent with the findings of a recent FAO study which concluded that water productivity seems to be lowest in water-scarce regions of agriculture-based economies (Bazza and Ahmed, 2002).

Water Poverty and Food Insecurity

To study the relationship between water poverty and food insecurity, a food security index (FSI) was calculated using data on annual per capita food consumption. Another food security index was calculated (GSI) using data on per capita grain consumption. The calculations of FSI and GSI are based on the following formula (Lawrence *et al.*, 2003):

$(X_i-X_{min})/(X_{max}-X_{min})$

Where X_i, X_{max}, and X_{min} are the original values for country i, the highest value country, and the lowest value country, respectively.

The calculated two food security indices were compared to water poverty index using correlation and regression analyses. Results clearly shows that positive correlation is found between WPI and food security index (FSI), suggesting that food security is associated with water availability. Fluctuations in food security are clearly following those of water poverty (Fig. 4). Results of regression analysis indicate that water poverty explains nearly 43% of the variation in food security (Shideed, 2004).

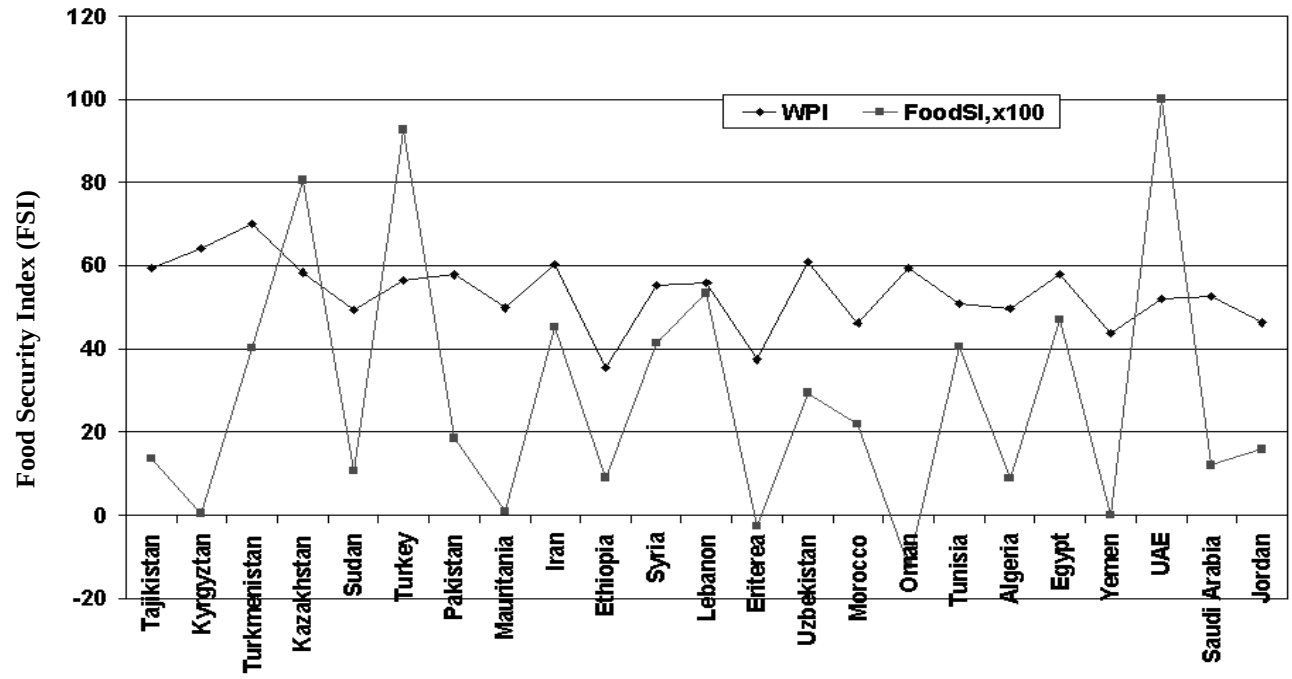

Fig. 4. Relationship between food security and WPI in CWANA.

Policy, Research and Investment Implications

This study provides evidence on the importance of studying the food security alongside the water poverty in CWANA region. Having water scarcity contributing to nearly half of the variation in food security will have important policy, research, and investment implications. Food insecurity is greatly explained by water poverty, and thus the two problems need to be addressed as interrelated and in an integrated approach. Both problems require immediate and equal attention at various policy and managerial levels.

Conflicts and production shortfalls are two major causes of shocks in food supplies in most of the food insecure countries including CWANA region. FAO estimated average agricultural output losses due to political conflicts in developing countries at $4.3 billion annually, an enough amount to provide nutritionally adequate food for 330 million undernourished people (USDA, 2003). Conflicts combined with food shortfalls accounted for six out of the seven famines occurred in Africa during the last two decades. Economic shocks affect food security in countries with limited resources, where domestic production is strongly linked to consumption and agricultural sector is the major employer.

CWANA countries are characterized by high production risk because agricultural production;s largely produced in rainfed areas that are subject to severe weather variations. In addition, population growth contributed to further deterioration of the land, often leading to erosion, deforestation, and depletion of topsoil, which in turn increases susceptibility to drought. Investment in supplemental irrigation and improved water harvesting techniques would greatly stabilize the production of staple food crops, and thus contribute to improved food security and reduced vulnerability of rural livelihoods.

Slow growth of agricultural sector, in many CWANA countries, has led to the poor performance of cash crops, which are the main source of exports to finance food imports. As a result, share of CWANA in global agricultural exports declined during last years. Instead, the region has increased its global market share in food imports. Investment in agricultural research would lead to increased agricultural productivity (per unit area productivity and per unit water productivity), and thus increasing the region s food security.

Food security is the foundation for social security. Therefore, short-run actions to mitigate and prevent food insecurity should be combined with long-run food security strategies. Expanding the use of improved technologies to increase productivity and thus farm income would enhance the capacity of farmers to cope with production shocks and instability. In CWANA region, particularly in WANA, there is huge potential to increase yields for staple crops consumed by the poor and the general public. Actual farm yields of crops in the region are far below their potentials.

ICARDA research has shown great potentials for increasing water productivity through the use of supplementary irrigation, water savings by improving on-farm water use efficiency, water harvesting, deficit irrigation, improved cultural practices, and germplasm improvements. To disseminate these technological advances to farmers, ICARDA has developed and implemented several regional projects, using integrated natural resource management approach (INRM) in cooperation with national programs and full participation and involvement of rural communities. The interventions include a package of technical, institutional and policy options targeting conserving the scarce water resource and optimizing its use. If policy makers encourage the adoption of appropriate technical as well as incentive packages, water-use efficiency can be improved. Consequently, huge amounts of water can be saved and be used to produce more crop production leading to increasing water productivity and food security.

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الأمن الغذائي وندرة المياه في إقليم وسط وغرب آسيا وشمال أفريقيا

كامل حايف شديد [1]

الخلاصة

واجه إقليم وسط وغرب آسيا وشمال أفريقيا تحديات جسيمة في زيادة الإنتاج الزراعي خلال الأربعة عقود الماضية، وذلك نتيجة للعديد من العوامل، من بينها محدودية الأراضي الصالحة للزراعة وندرة المياه، قلة وتذبذب الأمطار مع تكرار سنوات الجفاف، نمو السكان، انخفاض معدلات نمو الإنتاجية، زيادة الهجرة من الريف إلى المدينة، قلة الاستثمارات العامة والخاصة في الزراعة البعلية، ضعف أجهزة الإرشاد والسياسات الزراعية، وانخفاض معدلات تبني التقنيات الحديثة. وقد حقق الإقليم معدل نمو سنوي مقداره 2.9% في إنتاج الحبوب خلال الفترة 1962–2002. ويعزى معظم النمو إلى زيادة الإنتاجية بالدرجة الأولى وإلى التوسع في المساحات المزروعة بالدرجة الثانية. حيث حققت الإنتاجية والمساحة المزروعة معدل نمو سنوي مقداره 1.5%و1.3%، على التوالي خلال نفس الفترة. وكذلك الحال بالنسبة لإنتاج البقوليات والذي حقق نمو مقداره 1.6% سنوياً نتيجة للتوسع في المساحة المزروعة، حيث مثلت زيادة الإنتاجية فقط 20% من نسبة النمو هذه. ومن المتوقع أن يتغير نمط استهلاك الغذاء بشكل كبير خلال العقدين القادمين استجابة لزيادة السكان وارتفاع متوسط دخل الفرد، والتغيرات في ذوق المستهلك. حيث من المتوقع أن يزداد متوسط الاستهلاك الفردي من اللحوم بمعدل 29% للدواجن و19% للحوم الحمراء خلال الفترة 1997 و2020. وكذلك الحال بالنسبة لمعدلات الاستهلاك الفرد من المنتجات الحيوانية الأخرى. فقط معدل الاستهلاك الفردي للقمح والذرة من المتوقع أن تنخفض بنسبة 2% و16% على التوالي. وهذا الانخفاض في استهلاك القمح والذرة سوف يؤدي إلى تقليص الفجوة الغذائية للحبوب بشكل محدود جداً. حيث من المتوقع أن تنخفض هذه الفجوة في إقليم وسط وغرب آسيا وشمال أفريقيا من 46 مليون طن في عام 2002 إلى 35 مليون طن عام 2020.

وتشير المعلومات المتوفرة عن الرقم القياسي لندرة المياه ومكوناته إلى أن الموارد المائية النادرة أصلاً في الإقليم يتم استعمالها بصورةٍ سيئة ولم تتم إدارتها على نحو مستدام. إضافة إلى ذلك فإن سكان الإقليم لا يحصلون على المياه بصورة مناسبة. وعند مقارنة مقاييس ندرة المياه مع تلك الخاصة بالأمن الغذائي باستخدام تحليل الارتباط والانحدار، أتضح بأن هناك علاقة موجبة بين ندرة المياه وعدم تحقيق الأمن الغذائي، حيث يوضح الفقر المائي حوالي 43% من التغيرات في الأمن الغذائي. وتوفر نتائج هذه الدراسة مؤشرات هامة حول ضرورة دراسة الأمن الغذائي بشكل متلازم مع ندرة المياه في الإقليم، وذلك كون ندرة المياه تفسر حوالي 50% من التغيرات في الأمن الغذائي لما له من تطبيقات هامة للأغراض البحثية والاستثمارية والسياسات الزراعية. وهذا يتطلب انتباه فوري ومتساوي لمشكلتي الأمن الغذائي وندرة المياه كونهما مشكلتان مترابطتان ومن خلال معالجتهما باعتماد طرق الإدارة المتكاملة للموارد الطبيعية.

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