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Jordan National Report

HARNESSING SALTY WATER TO ENHANCE SUSTAINABLE LIVELIHOODS OF THE RURAL POOR IN FOUR COUNTRIES IN WEST ASIA AND NORTH AFRICA: EGYPT, JORDAN, SYRIA AND TUNISIA

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Background Information:

Jordan is located between 29 and 33 degrees north and 36 and 19 degrees east, situated near the southeastern coast of the Mediterranean. Jordan has a population of about 5.039 million. It borders with Syria to the North, Iraq to the East, Saudi Arabia to the South, and the occupied territories and Israel at the West. The total area of the kingdom is about 89200 square kilometers (Km^2). Its land area (88600 Km^2) represents 99.3% of the total area, while the balance, 600 km^2 is inland water; mainly the Dead Sea. Agricultural land is limited to 8% of the total land area in Jordan; this land is heavily dependent on irrigation. The dependence on rain for irrigation, and seasonally fluctuating agricultural production, creates a heavy reliance on agricultural imports, though Jordan does manage to export some agricultural produce. The majority of Jordan's agricultural produce (over 60%) is grown in the Jordan Valley; this area of the country that is below sea level has a warm and temperate climate all year round. This offers ideal conditions for planting vegetables and fruit. Agricultural production also takes place in the Highlands of the country, but mostly it is cereals and field crops, and seasonally, to a lesser extent, in fruits and vegetables. Agricultural production in the semi-arid eastern regions is very small and its contribution is generally low.

Table 1: General data on the country

Population (year 2000)	5.039 million
Surface area (km^2)	89287,1 Km^2
G.N.P / Capita (year 2000)	$7142.24
Agricultural surface area (ha)	684,000 ha
Added value of agriculture (year 2000)	$160.44
Share of agriculture in the G.N.P (year 2000)	2.2% of G.N.P
Share of employment in agriculture versus total employment (year 2000)	75,000 / 1,229,000

Jordan's water constraint is the main obstacle to the development of the agricultural sector, irrigation accounts only for less than three quarters (around 68%) of Jordan's water usage. The renewable fresh water resources are estimated at 1000-1200 MCM. In 1995, the water utilized for different purposes reached to 985 MCM amounting to about 237 m^3 per capita per year. According to water experts and UN classification, Jordan is a country which is under the water poverty line. Agricultural development in the country have concentrated on the highland rainfed areas and irrigated area in the Jordan Valley and the highland. The irrigated area amounts to 2% of the total area. With population increase at a high rate of 3.6%, and unexpected immigration, Jordan has no choice but to utilize any available source of land and water.

The climate is Mediterranean, with a long dry hot summer, a rainy winter, and a relatively drier spring and autumn seasons. Accordingly, the climate of Jordan is classified as an Eastern Mediterranean climate. Generally, the temperature increases towards the south. The average precipitation over Jordan is about 160 mm. Rainfall decrease towards the east and south, with rainfall ranging between 50 mm in the Eastern Badia and 600 mm in the Northern highlands. Rainfall occurs mainly in the winter season with heavy rainfall during January and February. The rain season normally starts in October and ends in mid May. The average annual rainfall decreases from west to east and from north to south reaching approximately nil in the Southeast corner of the Kingdom. It ranges between 400-600 mm in the Western Hills. To the east of these hills the altitudes fall off rapidly and the rain, mainly of orographic origin, also decreases. In the Jordan Valley, the average annual rainfall is 150-250 mm. On the Eastern Hills the rainfall again increases and reaches an average of 400-600 mm. From these hills to the east, the country slopes gradually and merges with the Syrian Desert and rainfall declines to less than 100 mm, occurring mainly due to weather disturbances.

Table (2) shows the average rainfall over Jordan's agro-climatic zones, the respective land areas in km^2, the percentage of total area, the weighted average rainfall depth, and the average volumes of rainfall in MCM/yr for each zone.

Table 2: Rainfall Depth and Distribution over Jordan's Zones

Area	Rainfall (mm)	Area (km')	Total %	Average Weighted Rainfall (mm/yr)	Rainfall Volume (MCM)
Desert	<100	633849	71.5	53.05	3,414
Arid	100-200	19,914	22.3	147.00	2,947
Marginal	200-300	l,965	2.2	250.24	513
Semi Arid	300-500	2,947	3.3	393.22	1,160
Humid	*>500*	625	0.7	650.00	390
Total		89,300	100%	93.60	8424

The annual potential evaporation in Jordan varies from 1900 mm in the Northwest as a minimum to more than 4400 mm in the south and in the east. About 70% of the annual evaporation is recorded in the dry season from May to October. These rates reach 80 times the average amounts of precipitation. The drainage system in Jordan consists of two major types: One drains rainfall towards the eastern desert depressions, and the other drains westward to the Jordan Rift Valley where it ends ultimately in the Dead Sea. The desert basins fall in the arid areas and most of their rainfall evaporates. The most important basin in terms of usable water is the Dead Sea Basin. It drains areas located in Syria, Lebanon, Israel and Palestine.

WATER RESOURCES AND THEIR CURRENT SITUATION:

The difference between the amounts of renewable water and the amount extracted is slowly leading to depletion and salinisation of the country's groundwater resources. This situation is being made worse by degradation processes affecting surface and ground water resources in different parts of the country. This limits their use to activities such as some agricultural and industrial use that can cope with the higher levels of salinity (MWI 2000). This of course is affecting the country's present generation of water users (water pollution, lower water quality, interruptions in supply, higher pumping cost due to lowered water level). Table 3 below shows each water resource and its relative importance, with surface and groundwater being of highest importance.

Table 3: Showing Jordan's water resources and their relative importance

Resource	Relative importance
Surface Water	39.3 %
Ground Water	47.2 %
Treated Water Reclaimed	13.4 %

At present, the largest consumer of water is agriculture, which consumes 72% of all Jordan's water resources. Municipal and industrial water users consume 24%, and 4% respectively (Table 4).

Table 4: Projected Annual Water Demand per Sector including Physical Losses[(1)]

Sector	Water Demand (including physical losses) [MCM, (%)]			
	2005	2010	2015	2020
Municipal and Tourist	372 (24)	415 (27)	460 (29)	513 (32)
Industry	59 (4)	77 (5)	100 (6)	120 (7)
Agriculture	1102 (72)	1072 (69)	1040 (65)	983 (61)
Total	1534 (100)	1564 (100)	1600 (100)	1616 (100)

The surface drainage in Jordan is relatively simple and consists of two components: Rain falling in the western part of Jordan which drains toward the Jordan Rift Valley, and rain falling in eastern part of Jordan which drains into desert depressions and the Red Sea. One of the most important water sources in Jordan is the Yarmouk River. The total flow of the River was estimated to be 492 MCM/year according to Jontiston plan (1955), which described the distribution of the Yarmouk water among Syria, Jordan and Palestine (90 MCM/year would go for Syria, 25 MCM/yr for Palestine, and approximately 377 MCM/year for Jordan).

Currently, about 1534 million cubic meters (MCM) of water are being exploited and utilized by different sectors, resources availability are presented in Table 5.

Table 5: Resource Availability in Jordan for the Years 2005 – 2020[(1)]

Year	Additional Resources	Base-flow	Ground-water	Dam Safe Yield*	Non-Conventional Water**	Total
2005	343.6	157.1	259.1	224.8	34.3	**1018.9**
2010	511.2	144.1	259.1	259.9	69.3	**1243.7**
2015	453.9	144.1	259.1	274.4	88.6	**1220.1**
2020	455.9	132.5	259.1	300.9	101.2	**1249.6**

** including treated wastewater discharged to wadis*
***Locally available treated wastewater*

(1) *National Water Master Plan, MWI, July 2004.*

About 41% of the total irrigated area is located in the arid and semi-arid regions, 39% is in the very arid region, and the remaining 20% of the total irrigated area is located in the semi-desert region. The irrigated area of the Jordan Valley and southern Ghors is about 30.4 thousand Hectare. The main source of irrigation water is from surface water. The rapid expansion of irrigation in the highlands (from 22,000 Hectare in 1980 to 32,000 Hectare in 1992) is the result of expansion in the use of groundwater. There is evidence that ground water resources are being stressed (increasing salinity in the Wadi Duhleil and Azraq basins). This could have a negative effect on highland irrigated production in the future. The share of treated wastewater is increasing and currently accounts for about 71 MCM, which is about 14% of the total irrigation water use (some 511 MCM/ year in 2002) and is expected to increase to about 150 MCM in 2010.

Restricted irrigation is done for about 780 Hectare and unrestricted irrigation for about 9,100 Hectare. While restricted irrigation is limited to fodders, cereals, forests and fruit trees, comprises unrestricted irrigation various vegetables, additionally.

Availability of brackish and saline water:

WATER NATURAL RESOURCES:

- Quantitatively:

Surface waters (millions m^3/year) : *505 MCM/Year*

Underground waters (million m^3/year) : *418 MCM/Year*

- Deep water tables (renewable resources) : *275 MCM/Year*
- Water tables *(non-renewable)* : *143 MCM/Year*
- Other (treated wastewater) : *65 MCM/Year*

- Qualitatively:

Salinity rate < 1 g/l : 89% of total

1-2 g/l : 6.56% of total

> 2 g/l : 4.44% of total

Other criteria:

Water in Jordan is classified as follows according to its quality:

Class A water, according to FAO standards, with a salinity less than 0.45g/l. It includes water of Yarmouk River, King Abdullah Canal, Wadi-Arab Dam, Shurahbiel Bin Hasna Dam, Shuaib Dam, Alkafrein Dam, as well as water from the wadis of the southern Ghore.

Class B water, according to FAO standards, it includes water discharged from King Talal Dam. Its salinity range is 0.45-2g/l.

The most important supply of surface water is the Yarmouk and Zarqa rivers. The Yarmouk River is suitable for irrigation (TDS=600ppm). The water quality of Zarqa River is deteriorated due to Kherbet Al- samra wastewater effluent (13500M^3/DAY). The water quality of the aquifers is declining due to unorganized over pumping.

Table 6: Water salinity for different resources.

Water resources	Water salinity TDS (PPM)
Yarmouk Aquifer	240-800
Yarmouk River	300-400
Jordan Valley Aquifer	450-3000
Wadi Araba	800-2500
Jafer and Disi	250-2246
Azraq	300-815
Al- Khalidiah	2000-5300
Zarka River	930-1230

Sixty seven saline water springs have been identified: 23 in the Jordan River Basin, 33 in the Dead Sea Basin, 8 in the Wadi Araba Basin, 1 in the Azraq Basin, and 2 in the Al-Jafer basin. The total average discharge was estimated to be approximately 46 MCM/year.

Table 7: Total average discharge (MCM/year) and water salinity (mg/l) of saline water springs in Jordan.

Basin	Average Discharge (MCM/year)	Average Salinity (mg/l)
Jordan River	21.03	1010-3860
Dead Sea	24.06	1020-7841
Wadi Araba	0.09	1110-1410
Azraq	0.74	1043
Al-Jafer	0.10	1100
Total	46.00	

SURFACE WATER RESOURCES:

Yarmouk Basin

Generally, the salinity of the water in the Upper Aquifer Complex varies among 300-5000 mg/1. Before many years, the water salinity was much below the 5000 mg/1 value (in north eastern part of the basin) but due to agricultural activities, water deteriorated very rapidly due to irrigation return flow. As water flows to the west, it attains different composition due to further water-rock interaction as well as partial mixing with the upward leakage from the Lower (Deep) Aquifer Complex. In certain parts of the basin especially in Ramtha area the water contains high concentrations of nitrates. Generally, the water in most parts of the basin can be considered to be of good quality and can be used for domestic, industrial and agricultural purposes. Restricted problems are associated in areas of high agricultural and human activities in the basin eastern part.

Jordan River Side Wadis and Jordan River Valley.

The water quality of the Upper (Shallow) aquifer Complex is considered to be suitable for the use of all purposes in the Jordan River side Wadis Basin. In contrary to this the water quality of the ground water resources in the Jordan River Valley where salinity increases rapidly due to the dissolution process of the evaporate in the Lisan Marl Unit as well as due to irrigation return flow. In most cases the water of the Upper aquifer in the Jordan River Valley is not suitable for domestic rises and even for industrial or agricultural uses.

Zarqa Basin

The water quality of the Upper Aquifer Complex in this basin is highly variable from one part to another. Generally the Zarqa Basin is divided into four main parts. Aqib Area, Dhuleil - Hallabat Area, and Dhuleil - Sukhnah Area.

In the four different parts water quality is widely varied. For example water salinity in the Aqib area varies between 300 - 5000 mar. The high salinity in the area is attributed to irrigation return flow, whereas intensive agricultural activities are still prevailing nowadays. In the lower reaches of the Dhuleil, where Khirbet Es-Samra stabilization ponds are located, the groundwater quality of the Shallow Aquifer has rapidly deteriorated since 1985 (the operation of Khirbet Es-Samra). The ground water in the area contains high concentrations of Nitrates, Ammonium, COD, Faecal Coliform, etc. The groundwater salinity in some wells reached more than 8000 mg/1, this deterioration is attributed to the infiltration of wastewater from the pond bottom and along the wadi. In Amman - Zarqa Area, the water quality is highly affected by the human activities where more than 50% of the population in Jordan live and most of the industries are located.

Azraq, - Basin

The water quality of the Shallow Aquifer Complex in the Azraq Basin varies very widely. The changes in salinity as well as the other constituents are ascribed to water-rock interaction in the central part as well as mixing processes between the fresh water body in the Basalt Aquifer and the highly saline water body in the Sabkha in the centre of the basin. In the last few years, water deteriorated very rapidly since pumping from the Upper Aquifer Complex in the basin exceeds twice its safe yield. Half of the extracted amount of water is utilized for irrigation purposes.

Dead Sea Basin

The water quality of the Upper Aquifer Complex in most parts of the Basin is considered to be of good quality and can be used for different purposes. Local salinization in the last five years was noticed in some areas where salinity reached more than 3000 mg/1. This was attributed to irrigation return flows in some places while in others, it was attributed to the over exploitation of the aquifer and upward leakage of the deeper Aquifer (saline and thermal).

The salinity of the ground water at the eastern shores of the Dead Sea increases very rapidly towards the Dead Sea. This is attributed to the dissolution of evaporates in the Lisan Marl Unit as well as the over exploitation of the alluvial Aquifer in the utilization for agricultural purposes.

Wadi Araba North, Red Sea, and Hammad Basins

The changes in the water salinity of groundwater along the flow lines in these basins are attributed to the characteristics of the aquifer. The water salinity starts with less than 600 mg/1 and increases downstream to reach more than 1500 mg/1. Mixing with the upward leakage from the Deep Saline aquifers along main structural elements especially in highly over-pumped well fields in Wadi Araba North Basin and in the Red Sea Basin is made also responsible for salinity increases.

Jafr Basin

The Upper (Shallow) aquifer Complex in the Jafr Basin was utilized for irrigation purposes during the sixties. Water quality deteriorated and the salinity increased to reach more than 1000 mg/1. The Intermediate Aquifer in the basin is of better quality and nowadays it is utilized for industrial purposes in the phosphate production.

Mudawwara - Southern Desert Basin

The water quality of the Disi Aquifer System is excellent, where salinity changes are very limited and ranges between 250 and 500 mg/1. The water of this aquifer is a non-renewable resource. Since around 10 years the water of the Disi Aquifer is utilized for agricultural purposes in Disi and Mudawwara Area, in addition to its utilization for domestic and industrial purposes in Aqaba. The overlaying aquifer contains highly saline water, where its salinity reaches a value of 8000 mg/1.

- The water quality of the Disi Aquifer, which forms the Deep Aquifer Complex either alone or together with other aquifers of the Kurnub Formation, or/and Traissic-Jurassic Formations in central Jordan, along the Dead Sea shore and the Jordan River Side Wadis and Valley varies according to the type of the combined aquifers. The water quality of the Disi and the Kurnub Aquifer is considered to be good whereas when the Triassic Jurassic joins the Aquifer System, water quality deteriorates and reaches a salinity of more than 6000 mg/1. This is attributed to the dissolution of evaporates present in the

Zarqa Group of Triassic-Jurassic Age. In central and along the Jordan Valley, the water quality of the Deep Aquifer Complex is considered to be thermal - mineral type.

- The Deep Aquifer Complex in the Jordan River Valley arid Side Wadis is considered to be a huge water resource and will be utilized in the future after desalination.
- The water quality of the Upper (Shallow) Aquifer Complex is now deteriorating and the salinity values, averages or ranges given in the different reports are not considered valid for the time being since higher values were recorded lately.

Catchments, Perennial Flows and Seasonal Flows

The drainage system in Jordan consists of two major types: One drains rainfall towards the eastern desert depressions, and the other drains westward to the Jordan Rift Valley where it ends ultimately in the Dead Sea. The desert basins fall in the arid areas and most of their rainfall evaporates. The most important basin in terms of usable water is the Dead Sea Basin. It drains areas located in Syria, Lebanon, Israel and Palestine.

The areas that were defined as surface catchments, their perennial and flood flows are shown in Table 8.

Table 8: Surface Water Resources in Jordan Long Term Average 1963-1989

Basin Name	Base Flow (MCM/Yr)	Flood Flow (MCM/Yr)	Total Flow (MCM/Yr)
1. Yarmouk at Adasiya	273.00	147.00	420.00
2. Ghor-Jordan Valley	19.30	2.40	21.70
3. North Jordan River Side Wadis	3 6.0 7	13.91	49.98
-Inter Catchments	5.10	4.54	9.64
-Wadi Arab	1.20	5.00	6.20
-Wadi Ziqlab	7.63	0.23	7.86
-Wadi Juram	10.30	0.20	10.50
-Wadi Yabis	2.62	1.63	4.25
-Wadi Kufranja	5.90	1.00	6.90

-Wadi Rajib	3.40	1.30	4.70
4. South Jordan River Side Wadis	24.76	8.40	33.16
-Inter Catchments	1.40	2.13	3.53
-Wadi Shueib	5.60	1.80	7.40
-Wadi Kafrein	13.44	3.53	16.97
-Wadi Hisban	4.2	1.01	*5.3*
5. Zarqa River	33.51	25.67	59.18
6. Dead Sea	53.95	7.20	61.15
-Inter Catchments	29.88	1.03	30.91
-Zarqa Ma'in	17.74	3.00	20.74
-Karak	6.33	3.17	9.50
7. Mujib	38.10	45.54	83.64
8. Hasa	27.40	9.04	36.44
9. North Wadi Araba*	15.63	2.57	18.20
-Inter Catchments	3.10	0.19	3.29
-Feifa	7.43	0.26	7.69
-Khanzera	2.32	0.42	2.74
-Dahel	0.03	0.23	0.26
-Fidan	1.66	0.48	2.08
-Buweida	0.80	0.16	0.96
-Musa	0.88	0.70	1.58
-Hawor	0.09	0.2	0.32
10. South Wadi Araba	3. 44	2. 1 6	5.60
-Inter Catchments	1.84	0.80	2.64
-Abu Barqa	0.60	0.37	0.97
-Roukaia	0.00	0.19	0.19
-Wadi Yutum	0.00	1.80	1.80
11. Southern Desert	0.00	2.15	2.15
12. Azraq	8.00	26.80	34.80
13. Sirhan	0.00	10.00	10.00
14. Hammad	0.00	13.00	13.00
15. Jafr	1.92	10.00	11.92
Total	534.08	326.84	860.92

* Includes Spring Flows ** Source: Water Authority of Jordan (WAJ) Files

Table 9: Main water Sources in Jordan Valley for the Hydrological Year 2001-2002

Sources EC	**< 1**	**1-2**	**2-3**	**3-4**	**4-5**	**5-6**	**6-7**	**7-8**	**>=8**	**TOTAL (MCM/YEAR)**
KAC	0	46.22	0	0	0	0	0	0	0	**46.22**
KTR	0	0	27.58	0	0		0	0	0	**27.58**
SIDE WADIS & RESERVOIRS	19.7	2.68	21.68	1.51	0	1.14	1.14	4.04	0	**50.74**
SPRINGS	0	4.55	2.38	3.37	0.15	0	0	0	0	**13.67**
DRAINS	0	0	0	0	0.23	0	0	1.4	0.56	**3.03**
TOTAL (MCM/YEAR)	19.7	53.45	51.64	4.88	4.05	1.14	1.14	5.44	0.56	**141.24**

The JVA Control Center in Dirar is monitoring the quantities and the JVA laboratory in the qualities of the primary water sources in the Jordan Valley. Since secondary water sources in terms of discharge and quality are often of local importance to farmers they have been included in the water source inventory and water-use monitoring program of brackish water (BW) in order to obtain sufficient information to assess their relevance for the farmers.

Wells and springs are regarded as point sources, whereas Jordan River (JR), King Abduallah Canal (KAC), wadis and drains are regarded as line sources and measured at fixed locations. Therefore JR, KAC, and drains appear as 'multiple' water sources with several measuring points.

Table 10. Irrigation Water Sources in the Southern Jordan Valley

Source	**EC_{iw} range (dS/m)**	**Totals**	**FW EC_{iw} < 3 dS/m**	**BW EC_{iw}>= 3dS/m**	**Remarks**
KAC	0.9-1.5	1	1		10 measuring points
KTR	1.7	1	1		1 measuring point
JR	3.7-6.4	1		1	5 measuring points
Other reservoirs	0.7-0.8	2	2		Kafrein, Shueib
Wadis	0.6-8.4	5	3	2	FW: Kufranhah, Rajeb, Hisban, BW: Al Khor, Zaraq
Wells	0.8-9.2	163	82	81	25 wells are located outside DAs, but used for irrigation; 10 wells supply RO plants for desalination; additional 24 wells are temporarily closed
Springs	1.9-15.0	27	10	17	
Drains	2.3-16.4	20	2	18	
Totals		220	101	119	

Water with a salinity of ECiw = 0.7-3.0 dS/m (450-2000 ppm) is classified as slightly to moderately restricting the use for irrigation, above 3 dS/m as severely restricting. Taking into account the relatively light soils and relatively high CaCO3 contents in many soils of the project area the BWP regards water of ECiw >= 3dS/m as brackish water (BW) and below as freshwater (FW). Water sources above 10 dS/m have no practical relevance for agricultural irrigation unless their water is desalinized. According to the threshold of 3 dS/m, 19 water sources (54%) in the Ghor area are brackish. This means an increase of 10 BW sources as compared to 2001, which is mainly due to the fact that new wells were discovered in the southern area. Many of these sources have local importance; however none of the BW sources is included in the supply network of JVA.

There are about 5700 farm units between Wadi Kufranjah and Sweimeh. In 2002, 1251 farm units (22%) were not irrigated and 4424 units (78%) were irrigated using various FW and BW sources in the area. Focusing on the importance of the use of BW and private FW sources, the following observations and assessments are interesting:

- In 2002 there are about 561 farm units using at least one BW source (11% less than in 2001). Out of these, only 171 units use only BW (5% more than in 2001), five units use BW and private FW, and 380 unit use BW and JVA-FW sources (16% less than in 2001).
- Assuming an average farm unit size of 3.0 Hectare and yearly irrigation depth of 1000 – 1300 mm with a 70 – 100% fraction of BW or private FW, the yearly volume of irrigation water from other than JVA sources in the Southern Jordan Valley amounts to roughly 23.5 MCM compared to about 58.8 MCM supplied by JVA from Wadi Kufranjah to the Dead Sea. (JVA Control Directorate in Deir Allah)

This assessment stresses the importance of BW in the southern Jordan Valley, which in the 2001/2002 growing season amounted to about 8.4% of the total amount of water used for irrigation. Another 10% of JVA-FW and private FW is applied on fields together with BW.

Rural poverty:

GENERAL:

A major challenge facing governments and societies world wide on the threshold of the twenty first century is to achieve sustainable economic growth and alleviate poverty without jeopardizing the quality of the environment. While this is a task of global significance, it presents particular problems to the agricultural sector because of the direct links between production and the natural resource-base, especially in the developing countries where dependence on agriculture for income and employment is generally high.

The natural resources have been subjected overtime to various processes causing their deterioration, partly as a consequence of natural factors such as drought and climatic variability, and partly due to the demands of an increasing human population. Desertification is a multiple process, which poses maximum threats to the arid and semi-arid ecosystems, the displacement of people, and the degradation of biodiversity. In the Arab countries, soil salinity is another major cause of degradation with serious implications for water management, where arid land represents 89 percent of their total area, and with 69 percent receiving less than 100 mm mean annual precipitation.

There is a growing awareness that rural development is an important of the overall-enabling environment for successful poverty reduction. The multiplier effect of such development is sustainable in terms of increased economic activity and off-farm employment and the building up of assets in the rural sector. Therefore, promoting appropriate agricultural technologies and implementing research and extension programs that focus on developing technology are highly desirable

Jordan is potentially facing severe water scarcity. The limited availability of water to meet increasing demands has a macro affect, implying increased government expenditure to obtain water from distant sources and tensions with neighboring countries over supplies. At the micro levels water is one of many necessary purchases; one that has implications for health & sanitation. The Ministry of Agriculture referred that the internal renewable and usable water resources are than 175 cubic meter yearly. Therefore, water scarcity is another face for poverty.

A recent report concerning with IFAD strategy for poverty reduction in the Near East and North Africa (NENA), indicated that 47% of that population living in rural areas (127 million). Based on World Bank and local country data, the most conservative estimates indicate that about 55 million rural people live in abject poverty (with incomes of close to or less than USD 1 per day). Rural population living below poverty line in the Arab countries was estimated to be close to 43.5 million and they constitute 42% of total rural population or 21% of total Arab population in that year.

Jordan is one of the countries with relatively high population increase rate, high fertility rate (5.5%), and relatively low infant mortality rate (34 deaths per 1000 live births) Towards the end of 2001, the official unemployment rate was 14% while the unofficial estimates were between 22-24%.. Non-farm income has a great impact on poverty and inequality. In rural Jordan the poor receive 20 percent of their income from non-farm sources. So non-farm income increases inequality in Jordan. In rural Jordan, land is not very productive, and access is not highly prized. The best way to reduce poverty and inequality might be to focus on non-farm unskilled labor.

Only 30 percent of Jordan's cultivated land-base is irrigated and crop yields are low. So Jordan's rural population does not press for access to land because the attractive economic rates of return are found in the non-farm sector. Rural Jordan's rich earn less than 10 percent of their total per capita income from agriculture and more than 55 percent of it from non-farm sources.

Jordan implemented many pilot programs and projects that included different aspects of poverty alleviation and employment creation. About 6433 households with US$ 17.2 million benefited from Diversification of Income Sources Project (1994-2001). The Jordan Badia Research and Development Program were initiated to assure the sustainable development of the Badia and improve the living standards of its inhabitants. The development of productive and sustainable small ruminant-based systems, through the integration of crop and livestock production, with a view to improving the incomes and welfare of farmers were investigated through Mashreq and Maghreb project.

In Jordan, Only 9 per cent of the total area (89.3 thousand square Km) receives an annual average rainfall exceeding 200 mm, constituting the arable land. Rangeland in the semi-arid regions (less 200 mm) constitutes about 91 per cent of the land (about 8 million hectares). Only about one million hectare of the rangeland receives 100-200 mm average annual rainfall. These rangelands are deteriorated mainly due to human misuse and to the harsh environment conditions of these lands. Overgrazing, uprooting of shrubs for firewood, plowing rangelands for cereals crops and to establish land claims are the main factors that contribute to the misuse of range resources.

A recent report prepared by the United Nation Development Program (UNDP) 2001 indicated that the Gross Domestic Product (GDP) per capita is $ 1490, and the current population growth rate amounted to 2.6%. Furthermore, Jordan indicator of human development, as indicated by the Human Development Index (HDI) is medium (89 out of a list of 174 countries).

The level of livelihoods of rural family in Jordan became increasingly dependent upon the availability of food subsidies and any reduction in these subsidies will represent a real decline in their standard of living. A significant portion of rural income is spent on food. Furthermore, the combining effects of privatization and other ingredient of Structural Adjustment Program (SAP) could lead to deterioration of the rural economy.

On the other hand, agricultural reforms under privatization and SAP usually favor large and efficient farmers. This could lead to further deterioration in the small and poor farmer's position, increase rural inequality, land concentration and deepen poverty.

The poor in Jordan depend heavily on government employment to decrease inequality. Government wages provide 60 per cent of non-farm income for rural poor. But since the government of Jordan already employs far more workers than it can possibly use, advocating increased government employment to reduce inequality would not be a wise policy advise. From a policy standpoint, it would be better to reduce income inequality by focusing on non-farm unskilled labor as an important income source.

The Ministry of Social Development in partnership with the Department of International Development (UK) and UNDP estimated the absolute poverty line in Jordan in 1997 to be USD 55 per capita monthly (Measurements and Analysis of Poverty in Jordan, 1997). Absolute poverty incidence is estimated to be 33% in terms of population and 25% in terms of households. The Zarqa and Mafraq area have the second highest absolute poverty lines, while Amman ranks first and Balqa and Madaba provinces has the lowest absolute poverty in Jordan. However, in terms of the number of poor, Zarqa and Mafraq rank third after Amman and Irbid areas, the distribution of the absolutely poor is 18% in the Zarqa and Mafraq area. Using severe poverty line instead of absolute poverty line, the Zarqa and Mafraq area has the second rank in the highest severe poverty incidence (3.3%) and number of severely poor (21%).

Rural women play a key role in on-farm and off-farm activities. This is particularly evidenced in ecologically fragile areas where women are becoming increasingly responsible for the day-to-day survival of the family. Women tend to be more vulnerable than men to the effects of environmental degradation due to their involvement in harvesting common property resources such as wood and water. As women make a greater contribution to household income stability than men, a decline in women access to resources may have significant impact on household consumption.

LIVESTOCK IN JORDAN:

The list of livestock in Jordan includes sheep, goat, cow, poultry, camel and bee. During the period (1997-2002) an average of 1750 thousand head of goat, 585 thousand head of sheep, 65 thousand head of cow, 2550 poultry farms with a capacity of 32803 thousand birds, and 34.5 thousand of bee hives are available in Jordan.

For the same period, Jordan produced an average of 15.8 thousand tons of red meat (sheep, goat and cow meat), 107.2 thousand tons of white meat (poultry and fish meat), 189.5 thousand tons of liquid milk, and 825.5 million of table eggs.

Jordan exported 318 thousand head of sheep and goat, 700 tons of cheese, 22 tons of Jameed, 6 million of table eggs and 29.7 million of hatching eggs as an average for the period (1997-2002). Livestock imports include different kinds of livestock products. As an average for the same period, it imported 470 thousand head of sheep and goat and 28.9 thousand head of cows. At the mean time, Jordan imported an average of 28.4 thousand tons of red meat, 10.1 thousand tons of white meat, 12.4 thousand tons of powder milk, 1.6 million of hatching eggs and about 18 thousand tons of other livestock products.

The Kingdom is closed from being poultry and table eggs self –sufficient. Production of poultry meat and table eggs is closed to the available for consumption during the period (1997-2002). The self-sufficiency rate was about 97% for poultry meat and 101% for table eggs. While imports of red meat, dairy products, fish meat and honey are exceeded local production. The self-sufficiency rate was about 50% for red meat, 51% for dairy products and 17% for honey during the same period (MOA, 1997-2002).

Jordan is a net importer of livestock feed. The list of produced livestock feed includes in Jordan; barley, tiben, green feed and vetch. During the period (1997-2002), Jordan produced and average of 277.7 thousand tons of livestock feed. While, the list of imported livestock feed includes bran, olive cake, concentrates, barley, maize and tiben. For the same period, Jordan imported an average of 1181.1 thousand tons of livestock feed. Barley and maize are dominated within the imported group, followed by olive cake, tiben, concentrates and bran. While bran is dominated within the production group, followed by tiben, barley green feed and vetch (Department of Statistics, 1997-2002).

ENVIRONMENTAL IMPACT OF DESALINATION WATER ON LOCAL COMMUNITIES:

Water plays an important role in our life. Teaching people to use water wisely can help prepare citizens who will be concerned enough to ensure that there is plenty of safe, clean water for the future. However, one of the great challenges remaining in this century is a lack in availability of water. Water is all around us but reaching it or obtaining it in potable, or for that matter, in any form has remained a major problem.

Local initiatives involving affordable technologies in the areas of potable water are the key to providing agricultural resources in arid regions, as these sustainable agricultural resources rely on potable water to sustainable. Expanding population, enhanced living standards and decreased availability of fresh water has catalyzed much research in the area of obtaining potable water. Since a large majority of water supply is salt water, desalination methods such as reverse osmosis and electro dialysis have been developed. In addition to the practical limitation of small-scale usage, these methods are energy demanding, and are generally coupled to fossil-fuel sources.

Mafraq province includes a significant number of rural populations in Jordan, where rainfall is limited and very irregular. During the good years, agriculture in these areas produces satisfactory yields. However, reduced rainfall or prolonged dry spells are leading immediately to crop failure. Irrigation would be the logic solution but water scarcity and the high cost of irrigation infrastructure are major handicaps. Alternative solutions should be found to increase the quantity of water on farmer’s field. Desalination water and other technologies are proven innovations to increase food security in drought prone areas.

Availability of water would lead to agricultural development, particularly irrigation expansion, and will bring noticeable changes in the cropping patterns. A considerable crop diversity, new production practices, and introduction of new crops in the drier areas are also expected results. At the mean time, raising awareness of all stakeholders and making participants familiar with those technologies are highly urgent.

Water Projects which involved the local community from the outset in the planning, implementation and maintenance have the best chance of enduring and expanding. Those projects which have been predominantly run by local people have had a much higher rate of success then those operated by people foreign to an area. Successful water projects are generally associated with communities that consider water supply a priority.

Prospects for biosaline agriculture:

With fresh water resources in the region approaching full utilization the quantity of fresh water available for the agricultural sector is diminishing due to the high rate of population growth, urbanization, and industrialization. Therefore attention was given to the use of low quality water resources where special problems confront and challenge agriculturists. Potential for agricultural production, food scarcity, and food security motivate scientists and farmers to seek new management practices in order to coexist with salinity problems.

The current situation regarding the status of the natural resources will highlight some of the main issues to be considered.

Table 11: Planted Area, Harvested area, and Production of Field Crops in Uplands, 2001

(Area: 100 Hectare, *Production: 1000 M: Ton)*

Crop	Production	Harvested Area	Planted Area
Wheat	17.24	116.50	425.57
Barely	15.74	192.09	826.40
Lentils	1.91	15.62	19.70
Vetch	1.10	8.99	12.65
Chick-peas	0.81	3.27	7.80
Maize	3.55	4.40	4.42
Sorghum	0.01	0.01	0.01
Tobacco, local	0.05	0.38	2.32
Garlic	2.71	0.49	0.49
Vetch-common	0.11	0.34	0.38
Clover trefoil	36.57	9.85	18.61
Alfalfa	3.74	0.52	0.52
Others	0.26	0.95	0.95
Total		353.42	1,319.81

Source: Jordanian Department of Statistics: Annual Agricultural Statistics for 2001

Table 12: Quantities of reused treated wastewater (2002)*

Total irrigation water (incl.treated sewage)	MCM/year	444
Total wastewater for irrigation	MCM/year	71
Portion of total irrigation water	%	16
Wastewater for restricted irrigation[1)]	MCM/year	10
Wastewater for unrestricted irrigation[2)]	MCM/year	59
Via King Talal Reservoir[3)]	MCM/year	57
Via Wadi Shua'ab Reservoir[4)]	MCM/year	1.9
Via Kafrein Reservoir[5)]	MCM/year	0.5

1) Inside, near to or downstream of the treatment plants' area

2) Deducted by 8% losses during transmission and storage (irrigation the Jordan Valley)

3) Treated effluent of As Samra, Baqa and Jerash Treatment Plants

4) Treated effluent of Salt and Fuhis Treatment Plants

5 Treated effluent of Wadi Essir Treatment Plant

)

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Table 13: Irrigated and Non-Irrigated Areas Under Fruit tress, Filed Crops and Vegetables in Jordan, 2001

(Area: 100 Hectare*)*

Crop	Non-Irrigated Area	Irrigated area	Total Area
Fruit Trees	524.48	353.21	877.69
Field Crops	1,301.09	79.95	1,381.04
Vegetables	4.33	301.29	305.62
Total	**1,829.90**	**734.45**	**2,564.35**

Source: Jordanian Department of Statistics: Annual Agricultural Statistics for 2001

Table 14: Area, Number, and Production of Fruit trees in Jordan in 2001

(Area: 100 Hectare*, No. of Trees: 1000 Tree, Production: 1000 M: Ton)*

Crop	Production	Number of Bearing Trees	Total Number of Trees	Area
Citrus Fruit	136.62	2,105	2,279	77.48
Olives	65.82	5,335	8,512	641.01
Grapes	25.91	1,756	2,205	37.87
Figs	1.73	141	181	5.67
Almonds	1.00	149	175	4.78
Peaches	8.07	534	681	16.14
Plums, Prunes	2.91	212	3271	6.50
Apricots	3.03	253	340	7.84
Apples	37.13	1,921	2,759	39.63
Pomegranates	3.89	140	163	3.96
Pears	0.92	96	123	2.63
Guava	2.23	73	79	1.76
Dates	1.42	36	44	2.64
Bananas	24.32	2,214	2,506	23.59
Nectarines	0.93	51	53	1.20
Cherry	0.84	70	81	1.90
Others	2.44	137	152	3.09
Total		**15,224**	**20,605**	**877.69**

Source: Jordanian Department of Statistics: Annual Agricultural Statistics for 2001

Table 15: Safe yield of groundwater basins in Jordan

Basin	Safe Yield (MCM year)
Yarmouk Basin	40.0
Jordan River side Wadis	15.0
Jordan Valley Basin	21.0
Amman-Zarqa Basin	87.5
Dead Sea Basin	57.0
Azaq Basin	24.0
Others	31.0
Total	275.5
Source: El-Naser/Elias (1993), p.2	

Table 16: Irrigated areas in Jordan and their water requirements until the year 2010

Water Source	Region	Irrigated areas and yearly water requirements									
		1990		1995		2000		2005		2010	
		Ha	MCM	Ha	MCM	Ha	MCM	Ha	MCM	Ha	MCM
Surface	Jordan Valley	22828	370	28800	338	31000	370	35000	419	36000	425
Water	Southern Ghors	4700	44	4700	44	8500	79	8500	79	8500	79
	Side Wadi Banks	1500	10	1500	10	2000	12	2000	12	2500	15
	Total	29028	324	35000	392	41500	461	45500	510	47000	519
Ground	Jordan Valley	2000	20	---	---	---	---	---	---	---	---
Water	Highlands	24500	170	24500	170	25000	175	25000	175	25000	175
	Disi-Mudwwara	5000	37	5500	40	5500	43	6000	43	6000	45
	Wadi Araba	200	neg.	500	5	1000	10	1000	10	1500	15
	Total	31520	227	30500	215	31500	228	32000	230	32500	235
Grand total		60548	651	65500	607	73000	689	77500	740	79500	754

Two approaches for increasing crop production with the use of saline and slightly saline water are feasible, these are:

1- changing the environment to improve conditions for the plants; or

2- changing the plant genetically to better tolerate the saline root zone environment.

Even though the second approach is semi authentic, the first one aims to provide the proper culture for the second one to optimize crop production on sustainable basis. In this regard, a research had been conducted by Fardous et al (1997), the results showed that barely grain yield irrigated with water of 6.5 dS/m was higher than that irrigated with water of EC = 0.8 dS/m (3.08 ton /ha). For sugar beet tubers, irrigation water of 6.5 dS/m resulted with 84% of yield with water of 0.8 dS/m. However the yield of onion was reduced by 54% when it was irrigated by saline water (6.5 dS/m) compared with fresh water (0.8 dS/m).

In general, Jordanian farmers use on their farms brackish irrigation water to produce the following crops both in the Jordan Valley (Ghor area) and the northeastern parts (areas around Azraq, Dhuleil and Khaldieh):

Tomatoes, Muskmelon, Wheat, Sugarbeet, Jewsmelon, Cabbage, Eggplant, Squash, Asparagus, Pepper, Date palm, Sudan grass, Okra, Barley, Watermelon, Melons, Corn, Sorghum, Vetch, Clover, Atriplex, Banana, Olive and Pistacio.

Among these crops, the mostly favored crops in the sellected target areas are Tomatoes, Eggplant, Sugarbeet, Pepper, Vetch, Clover, Sudan Grass, Okra, Barley, Watermelon, Corn, Sorghum, Atriplex, Olive, Pistacio and Date Palm (mostly in Azraq region). The farmers have locally aquired enough experience on their own to manage their fields and get an acceptable produce (both quantitatively and qualitatively) using available water sources fresh and/or brackish water on good and/or saline soils.

The farming systems in the areas where saline water sources are available is dependant on the location. In the Jordan Valley (Southern Ghor and South of Dead Sea) the cropping pattern is mostly irrigated vegetables dominated by Tomato, Jewsmelons, Melon and Watermelon. Other important crops are Banana, Date Palm, and some Grapes. In Azraq area, the cropping pattern is dominated by Date Palm and Olive trees. Other crops are Vetch, Clover and grain crops mainly Corn and Barley. In Mafraq area (including Dhuleil and Khaldieh) the dominant crops are Olive trees followed by irrigated vegetables (mostly Tomato) and fodder crops (Vetch and Clover).

Considering the national agricultural strategy, fodder crops, grain crops (wheat, barley, corn, sorghum) and pistacios have high priority as their level of self-sufficiency is low. Increasing production of these crops will help to improve both the rural livihoods and the national economy.

EXPLORING THE DEEP-WATER AQUIFERS:

As a result of the water-balance deficit, Ministry of Water and Irrigation (MWI) conducted a program to study the deep-water aquifers to utilize its waters for drinking purposes in various areas in Jordan. Eight wells are being currently excavated in Lajoon area to penetrate the Disi Aquifer, so as to study the characteristics of the aquifer quantitatively and qualitatively, assess the results of the study so as to use its water for drinking purposes in both Amman and Karak. To fulfill studying the hydrological characteristics of these aquifers, deep excavation in the Qataraneh and Sukhneh areas have recently took place. There is an expanding trend in exploring other deep-water aquifers in the rest of the kingdom.

JORDAN'S WATER POLICY :

Policies and strategies for exploiting the growth potential of irrigated agriculture Pricing publicly developed and managed water to reflect the importance and scarcity in Jordan establishing an irrigation time schedule for the Jordan Valley on the basis of crop water requirements. To enable the government to provide farmers with irrigation water at the proper time and desirable quality, a demand driven water supply system will be set up. Exempting the imported materials required for the local manufacture of water saving technologies for customs duties, in order to minimise the production costs of such equipment. Enforcing regulations relating to the licensing of groundwater wells, and monitoring ground water extraction and recharge of main ground water aquifers to ensure the sustainability of the water supply with regard to quality and quantity.

Private Sector Participation is considered in the strategy, the following factors are highlighted:

1- The role of the private sector in the development of fresh groundwater resources shall be reduced where reduction of abstraction is sought. The private sector shall be encouraged to co-operate in the rehabilitation of aquifers where needed.
2- The private sector shall be encouraged to develop aquifers of marginal water quality for use in irrigation. It shall also be encouraged to develop fossil and renewable aquifers in remote areas for agricultural uses with the intention of promoting technology transfer and the creation of job opportunities.

3- Desalination of brackish groundwater by the private sector shall be promoted. Care shall be given to the environmental impacts of such activities, particularly the safe disposal of brines.

On Resource Development and Use, the following are considered in the strategy:

1- For irrigation purposes, and in light of the tight water situation, wastewater is considered a resource and cannot be treated as "waste." It shall be collected and treated to standards that allow its reuse in irrigation unrestricted by health and public health considerations or unduly constrained by high salinity contents.
2- In remote sparsely populated areas, and after satisfying the local municipal and industrial needs from unallocated water resources, water resources shall be allocated to agricultural production including livestock. Such development shall be planned and implemented in an integrated social and economic fashion in order that communities can be formed, settled and developed.
3- Maximum use shall be made of rainfall for crop production, and supplementary irrigation shall be employed to maximize production including increasing cropping intensities.
4- The use of brackish water in irrigation shall be pursued with care. Soil salinity resulting there from shall be monitored and its buildup managed and mitigated. Land shall be managed with the attention it deserves as a non-renewable resource.
5- A revolving development plan for water resources, including irrigation resources, shall be adopted. The use of modern techniques made available by software development will be employed for the purpose.

In regard to technology transfer and adaptation, the following are stated:

1- Despite the high percentage of agricultural water uses, the quantities used fall short of the needs. Higher agricultural yields shall be targeted and the transfer of advanced technology shall be endorsed and encouraged. The transformation of traditional irrigation and farming practices into modern methods shall be endorsed and promoted.
2- Such advanced methods as drip irrigation, spray irrigation, micro-sprinkler irrigation are favored over less efficient methods. Local manufacturing of these systems will be encouraged.
3- Irrigation water conveyance and distribution shall be made through the installation of pressure pipe networks. Maximum use shall be made of gravity-generated pressures to operate these systems.
4- Operation of the irrigation network will be improved to have the water filling the network for 24 hours. Such operation will enhance the benefits that accrue from drip irrigation. While in a rotation system the drip irrigation pipes act as on-farm conveyor, 24-hour operation has the advantage of operating the drippers as designed.
5- Plant varieties developed as a result of genetic engineering research shall be favored for introduction into Jordan's markets. Maximizing resistance to pests, salinity and adverse conditions are features that are needed. Additionally, the maximization of crop yields is another beneficial feature of such varieties.
6- Leasing of Government lands with permits to use water resources not earmarked for higher priority uses, especially in remote areas, shall be encouraged with the

view of introducing advanced agricultural practices. Cooperation with advanced countries through technical co-operation shall be sought and promoted to advance technology transfer and adaptation.

On-Farm Water Management:

1- Crop water requirements in the various micro-climatic zones of the country shall be experimentally determined, taking into consideration the prevailing different water qualities.
2- Farmers shall be encouraged to monitor soil moisture on their farms to determine the timing for irrigation water application. The rate and duration of the application shall be adjusted to match the crop water requirements.
3- In as much as is practical, investments on the farm to provide overnight water storage facilities shall be discouraged through providing a continuous supply of irrigation water in the distribution networks.
4- Along with water management, farmers should be able to manage such other agricultural inputs as chemical fertilizers with the irrigation water.
5- Night application of irrigation water, especially in the dry season, shall be encouraged to reduce evaporation losses.
6- Automation of on-farm irrigation networks and their operation will be encouraged and training of farmers on advanced water management techniques shall be sought by cooperating with the research and extension service of the Ministry of

Agriculture. Cooperation with other countries in this regard and in technology transfer in general shall be pursued.

7- Programs shall be prepared to raise the public and farmers awareness of the availability of reused water, its rational and economic use and on the impacts of its quality.

Finally, on Irrigation Water Quality:

1- Irrigation water quality shall be monitored through sampling at the sources and from the conveyance and distribution network. Farmers shall be alerted to any degradation of water quality. This is important so that they can plan the use of such water for the suitable farming purposes.
2- Where marginal quality water, such as treated wastewater effluent, is a source of irrigation water, care should be taken, to the maximum extent possible, to have the quality improved to standards that allow its use for unrestricted irrigation. This can be achieved through blending with fresher water sources.
3- The same applies to the potential use of drainage water or brackish water sources. However, farmers should be informed of the potential quality of irrigation water so that their choice of crops is made with the necessary background information and knowledge.
4- Soil salinity and water chemical contents are also constraining factors. Where its salinity is combined with water salinity, the environment of the root zone can cause high stress. Care shall be taken in providing testing services to farmers, and

in promoting extension service in such zones where soil salinity and irrigation water salinity produce hostile roots environments.

Conclusions:

Jordan is among the world's countries least well endowed with water resources. Its nearly 5.039 million inhabitants have far less water at their disposal than an arid country needs. This includes the water required for self-sufficient food production in irrigated agriculture, along with municipal and industrial requirements. Although the amount of water Jordan receives may not be easily increased, the efficient use of existing water resources can be. So, the safe utilization of saline water resources, without deteriorating the already limited and to some degree deteriorated land resources, is of utmost importance and is considered as a national need.

As the volume of saline water is increasing by time as a result of over-exploiting groundwater or due to pollution, there is a growing need to come out with an environmentally safe package to allow the use of such water qualities to both increase the planted area, and increase the production of strategic crops that are badly needed on the national level. There are no social, economic, or technical constraints to use saline water resources for agriculture in Jordan, as this would relief other fresh water resources for domestic uses, but all technical and environmental considerations should be regarded.

The water consumption from all sources is divided as follows: 300 MCM for municipal and industrial use and about 700 MCM for the agricultural sector. About 41% of the total irrigated area is located in the arid and semi-arid regions, 39% is in the very arid region, and the remaining 20% of the total irrigated area is located in the semi-desert region. The irrigated area of the Jordan Valley and southern Ghors is about 30.4 thousand Hectare the main source of irrigation water is from surface water. The rapid expansion of irrigation in the highlands (from 22,000 Hectare in 1980 to 32,000 Hectare in 1992) is the result of expansion in the use of groundwater. There is evidence that ground water resources are being stressed (increasing salinity in the Wadi Duhleil and Azraq basins). This could have a negative effect on highland irrigated production in the future. The share of treated wastewater is increasing and currently accounts for about 52 MCM and is expected to increase to about 85 MCM in the year 2000 and 150 MCM in 2010.

Ground water is considered to be the major water resource of many areas, and the only water resource in other areas in Jordan. At the present conditions and as over pumping continues, the estimated usable time for the ground water resources is around 40 years only.

Considering the national agricultural strategy, fodder crops, grain crops (wheat, barley, corn, sorghum) and pistacios have high priority as their level of self-sufficiency is low. Increasing production of these crops will help to improve both the rural livihoods and the national economy.

Appendices:

Appendix 1

Abbreviations

MCM – Million Cubic Meters

FAO – Food and Agriculture Organization of the United Nations

MWI – Ministry of Water and Irrigation

WAJ – Water Authority of Jordan

JVA – Jordan Valley Authority

JD – Jordanian Dinar

UN – United Nations

FW – Fresh Water

BW – Brackish Water

10 Dunums is equal to 1.0 Hectare

0.7 J.D. = $1

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